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V.I. Air quality

AMBIENT BACKGROUND LEVELS OF
AIR POLLUTION IN HAMILTON

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HAMILTON AIR QUALITY

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PARTICULATE EMISSION
CONTROLS BY STELCO

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REDUCTION OF AIR POLLUTION
EMISSIONS FROM DOFASCO

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Presented at Hamilton Environment '80

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135 Fennell Avenue
Hamilton

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Abstract

Background pollution can originate from many sources and can be transported over great distances before it enters an urban atmosphere. At times, this background pollution can significantly affect the air quality of a city.

In recent years, air monitoring stations have operated in unpolluted areas to identify background pollution levels. A network of stations was established in the region upwind of Hamilton to monitor the background levels of suspended particulate matter which can affect the city's air quality. This sampling network and some of its measurements will be described.

Background levels of particulate pollution in the region are shown and compared to levels observed within the city. These findings may partly explain why Hamilton has a particulate pollution problem. A profile of the levels as observed across the region is presented and the possible impact of background levels on Hamilton is discussed.

1. INTRODUCTION

Suspended particulate matter has been a concern in the city of Hamilton for many years. High concentrations of suspended particulates have been associated with the heavy industrial sector of the city. Studies in 1967 and 1970 showed the effect of regional wind direction on the distribution of concentrations over the residential and commercial areas around the industrial sector.^{1,2}

As a result of pollution abatement, substantial reductions of particulate emissions from major point sources have been achieved. Levels of total suspended particulates (TSP) have generally decreased at all seven TSP monitoring stations operating in the city since 1971. Nevertheless, levels frequently exceed the 24-hour Ontario standard for TSP and remain above the annual standard at some locations. One of the questions being asked is how much of the urban particulate pollution is coming into the city from surrounding regions.

Background particulate pollution coming into urban areas consists of natural, uncontrollable particulates, and manmade contributions.³ The latter includes emissions in rural areas and particulates transported from distant industrial and urban areas. Studies of several cities have shown that background particulate pollution can significantly contribute to the urban pollution problem.⁴

Traditionally, very little data have been available on background levels in Hamilton because most monitoring stations were located inside the city in order to meet the needs of the city's abatement program. A set of data suitable for describing some aspects of background particulate pollution has become available from a sampling network established in the year 1975 outside of the city.^{5,6} This network is described and some of the data are presented and interpreted to show the significance of background particulate pollution to the problem in Hamilton.

2. NETWORK DESCRIPTION

Study Region

Measurements of background TSP affecting urban air were made in the region most frequently upwind of the urban area. The locations of air sampling stations are shown in Figure 1. The region is predominantly flat, rural, lightly populated, and was without major sources of suspended particulate matter during the time of the measurements. It is bounded on the south by Lake Erie and on the north by Hamilton and Lake Ontario. The wind prevails in the region from the southwest direction. This has been substantiated by long-term observations at several meteorological stations located in the region. Southwest winds have been observed to occur about 35 percent of the time.

Source of Data

At each of the indicated locations (solid dots) in Figure 1, there was at least a partial program of sampling between June 1975 and December 1978. All stations monitored 24-hour TSP concentrations. High volume air samplers were used because they were inexpensive, easy to operate, and in widespread use. The collection of particles on glass fiber filters provided a reliable weight measure of the TSP concentration.

One disadvantage of the sampler is the lack of particle size selection. At four of the locations (circles) in Figure 1, particle size distribution was monitored using a four-stage (Andersen) fractionating cascade impactor with effective cutoff at 1.1, 2.0, 3.3, and 7.0 microns aerodynamic diameter.^a

The network sampled on a six-day cycle. TSP data of four stations (SD, SK, BS, NP) was obtained from the Ontario Ministry of Environment, West Central Region. Hourly wind observations were collected from as many as seven meteorological stations in the region.

^aAerodynamic diameter is the diameter of a spherical particle of unit density that has aerodynamic behavior identical to that of an irregularly shaped particle.

Sampling Site Selection

The two urban stations were located in commercial, residential areas on either side of the heavy industrial sector. All other stations were located either in or near open fields where measurements would represent ambient background concentrations. Stations were well recessed (at least 90 meters) from the nearest unpaved roadway.

3. RESULTS

Total Suspended Particulate

The 24-hour average concentrations accompanying a strong wind prevailing from the southwest on October 21, 1975, are shown in Figure 2. TSP concentration at each station is plotted on a profile of the region along the wind direction. Concentrations ranged from 42 to 55 $\mu\text{g}/\text{m}^3$ as measured in the region from Long Point, a location remote from land-based sources, to the outskirts of the urban area.

As the air passed over the region, concentrations were fairly low and homogeneous throughout the region. The concentrations in the region are nearly equal to those at Long Point which was at the forefront of incoming air. This suggests that the region contributed very little particulate pollution to the air coming into Hamilton. TSP concentrations did vary in the region from day to day, but invariably were less than those at the two urban stations.

Since all samples were accumulated over 24 hours, it was difficult to interpret the data in terms of other wind directions and continuously changing weather conditions. The results of many sampling days can be summarized as shown in Figure 3 for each calendar year. The number of samples comprising each annual geometric mean is shown in Table I. Annual background concentrations ranged from 37 to 54 $\mu\text{g}/\text{m}^3$, which is below the standard of 60 $\mu\text{g}/\text{m}^3$.

It is possible that some stations were occasionally affected by dust from the nearby environment, despite careful site selection. The daily concentrations in the region rarely exceeded the 24-hour standard of $120 \mu\text{g}/\text{m}^3$ (for example, only 4 out of a total of 125 sample days at Port Dover). However, at the urban stations, annual concentrations were more than double those in the region and did exceed the annual standard.

Particle Size

The distribution of particle size was found to be fairly consistent from day to day and from station to station. The average particle size distribution at each station for the year 1977 is shown in Table II. The average percentage of total concentration is also shown for each size range. It is interesting to note that these distributions are nearly identical even though there were large differences between urban and nonurban TSP concentrations. The data suggest that the percentage of TSP concentrations for each size range is nearly constant in the region. A slightly greater percentage of larger particles (greater than 7.0 microns) was observed at the urban stations. Generally, about two-thirds of the particles by weight are less than 7.0 microns aerodynamic diameter, indicating that most are inhalable.

During the past few years, several thousand measurements of particle size distribution in a variety of urban and nonurban surface locations have shown that the size distribution of suspended particulates is almost always bimodal in nature.⁷ The data shown in Table II suggest that particle size in the region is also bimodally distributed, but because of the limited groups of size fractions, a bimodal distribution cannot be definitely established with the cascade impactor.

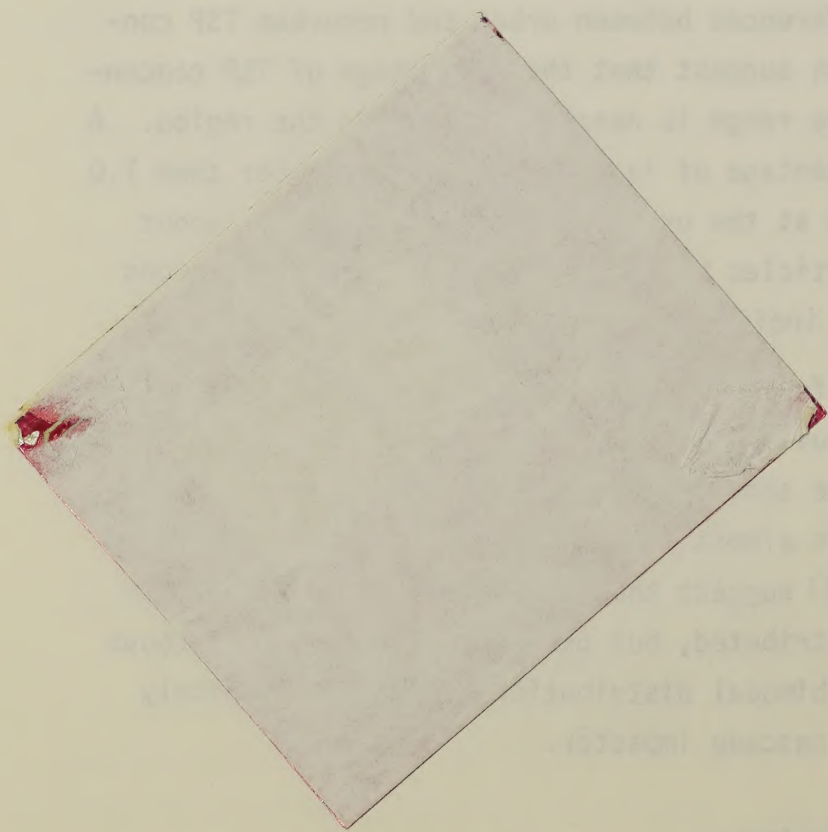
Comparison to Other Regions

Data from stations located in other rural areas of the Great Lakes region was obtained for comparison.^{8,9,10} Very little data

It is possible that some stations were overexposed to radiation from the test, but no such stations were identified. The daily concentrations in the region rarely exceeded the 150-gram standard in 1977. For example, only 2 out of 155 sample days at this station (measured at the water surface, 1977) concentrations were near the daily limit in the region and the entire the annual standard.

Particle Size

The distribution of particle size was found to be fairly consistent from day to day and from station to station. The average particle size distribution at each station for the year 1977 is shown in Table II. The average percentage of total concentration is also shown for each size range. It is interesting to note that these distributions are nearly identical even though there were large differences between the measured TSP concentrations. The data suggest that the range of TSP concentrations for each size range is nearly the same in the region. A slightly greater percentage of the total concentration was found in the 1.0- to 2.5- μ m range at the water surface (measured at the water surface, 1977) than at the other stations. This is probably due to the fact that the water surface is the only station where the wind speed was measured.



During the year 1977, the particle size distribution at each station was nearly identical. The data suggest that the range of TSP concentrations for each size range is nearly the same in the region. A slightly greater percentage of the total concentration was found in the 1.0- to 2.5- μ m range at the water surface (measured at the water surface, 1977) than at the other stations. This is probably due to the fact that the water surface is the only station where the wind speed was measured.

Comparison to Other Regions

Data from stations located in other parts of the Great Lakes region was obtained for comparison. The 1977 data

are available on background concentrations. The TSP concentration measured at stations located in nonurban areas remote from major point or area sources is shown in Figure 4 for the year 1977. These stations sampled on the same days as did the sampling network outside of Hamilton. The measurements represent the lowest levels of TSP found in the Great Lakes Basin and are similar to those in the region near Hamilton. In addition, measurements of background particulate pollution near other large cities, such as St. Louis¹¹ and Buffalo¹² have also shown similar levels.

Presently, very little information is available on particle size distribution in the Great Lakes region comparable to the network data. However, studies of Birmingham and New York,¹³ and of St. Louis,¹¹ have found distributions of particle size which are similar to those measured by the network.

4. DISCUSSION

Measurements of TSP upwind of Hamilton have identified background concentrations which can affect the urban air. These concentrations are significant when compared to urban concentrations. The particle size distribution at each selected monitoring station is quite similar.

Background concentration is a lower limit below which ambient concentrations cannot be reduced. At times, the addition of background and urban contributions to particulate pollution can result in unacceptable levels in the urban air which otherwise would have been acceptable if the background level were less. Measurements of background TSP concentrations showed the extent to which it is possible to reduce urban concentrations.

It was observed that the concentrations in the rural region were fairly homogeneous each day, suggesting that particulate matter from distant sources was well mixed. The background concentrations varied day to day, probably as a result of increased emissions and atmospheric conditions upwind of the region.

It should be noted that the regional background pollution may not always mix well with the urban air, for example, during periods of air stagnation. At such times, the dispersion of air pollution is limited and urban concentrations increase without the effect of background pollution.

During periods of mixing, background concentrations can be a significant component of the urban concentrations. It is possible that as urban levels continue to approach the background level, as a result of pollution abatement, smaller and smaller improvements will be observed. For example, several years ago when the annual urban levels were four to five times the background level, a 50 percent reduction of the urban contribution would have resulted in nearly a 50 percent reduction to the urban level. However, annual urban levels are currently much lower, about two to three times the background level. Therefore, a 50 percent reduction of the urban contribution would result in a much smaller reduction of the urban level. Thus, as the city continues to reduce particulate pollution, smaller improvements in the urban air quality may be observed despite major reductions within the city. It should also be noted that large percentage reductions, such as 50 percent, are technologically and economically more difficult to achieve today than they were many years ago when by simply adding pollution control devices for the first time, emissions were greatly reduced.

The network measurements identified background particulate pollution in an undeveloped region. They provide a basis for comparing air quality before and subsequent to future regional development and establish a basis for monitoring long-term trends in background particulate pollution. Measurements did not identify sources of pollution. This would require extensive chemical composition analysis, particle size analysis, and air parcel trajectory analysis.

5. CONCLUSION

A significant amount of the particulate pollution in Hamilton originates beyond the surrounding region. This background pollution cannot be controlled within the city. Instead, it represents the best air quality achievable by the city.

The measurements of the network identified the background levels on selected days over a 3-1/2 year time period. The region southwest of Hamilton was undetected as a source of particulate pollution. In the future, it may be possible to determine the exact origin of the suspended particulate matter coming into the region.

Acknowledgment

The establishment and operation of the sampling network was supported by funding from the Ontario Ministry of Environment: Air Resources Branch, Ontario Hydro and The Steel Company of Canada.

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Figure 1: Regional map showing locations of particulate sampling stations.

Figure 2: Profile of TSP concentrations across region on October 21, 1975.

Figure 3: Profile of annual geometric mean concentrations across region for 1976, 1977, and 1978.

Figure 4: Annual geometric mean of background TSP concentrations for the year 1977 in the Great Lakes Region.

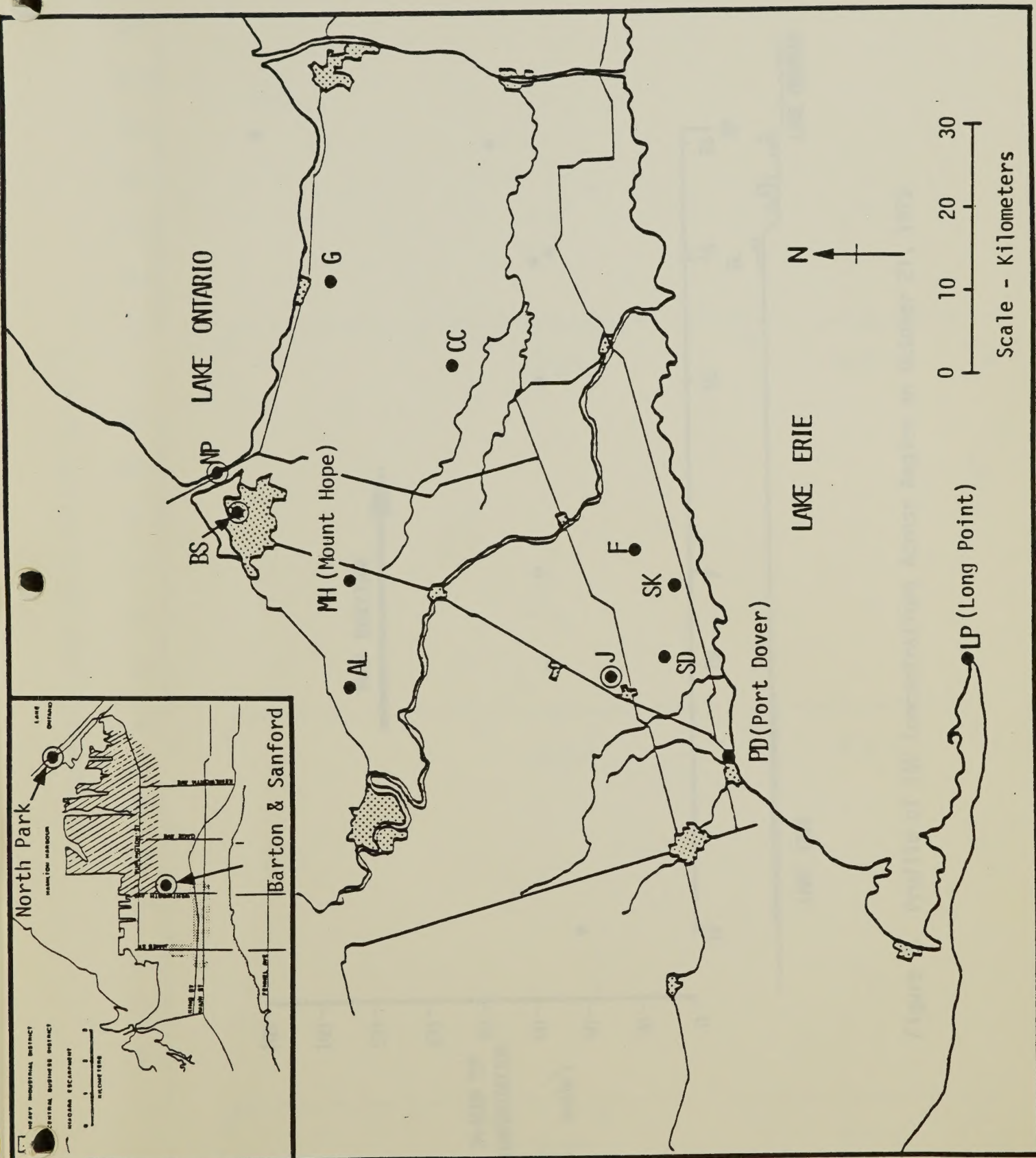


Figure 1. Regional Map Showing Locations of Particulate Sampling Stations

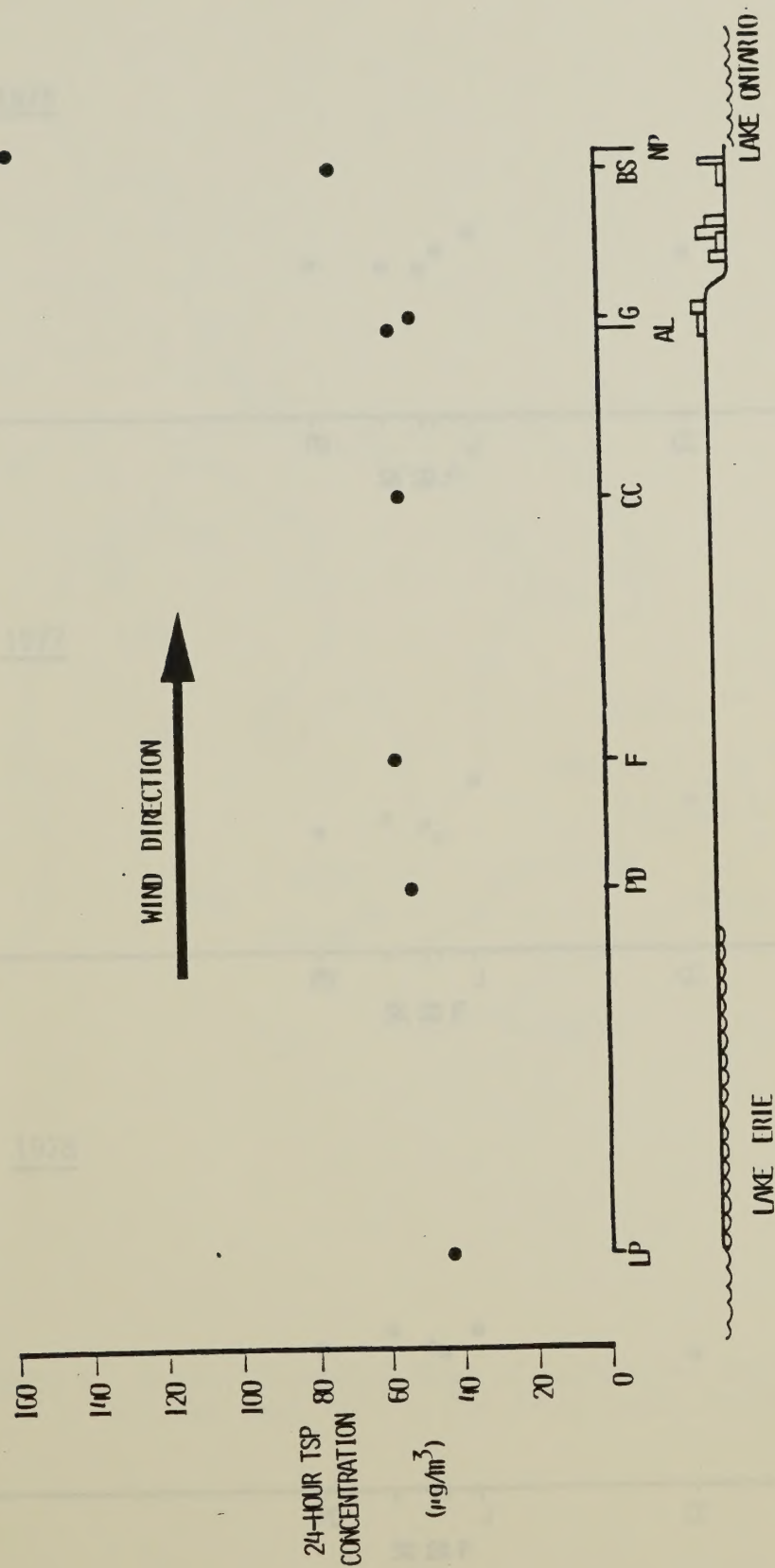


Figure 2. Profile of TSP Concentrations Across Region on October 21, 1975

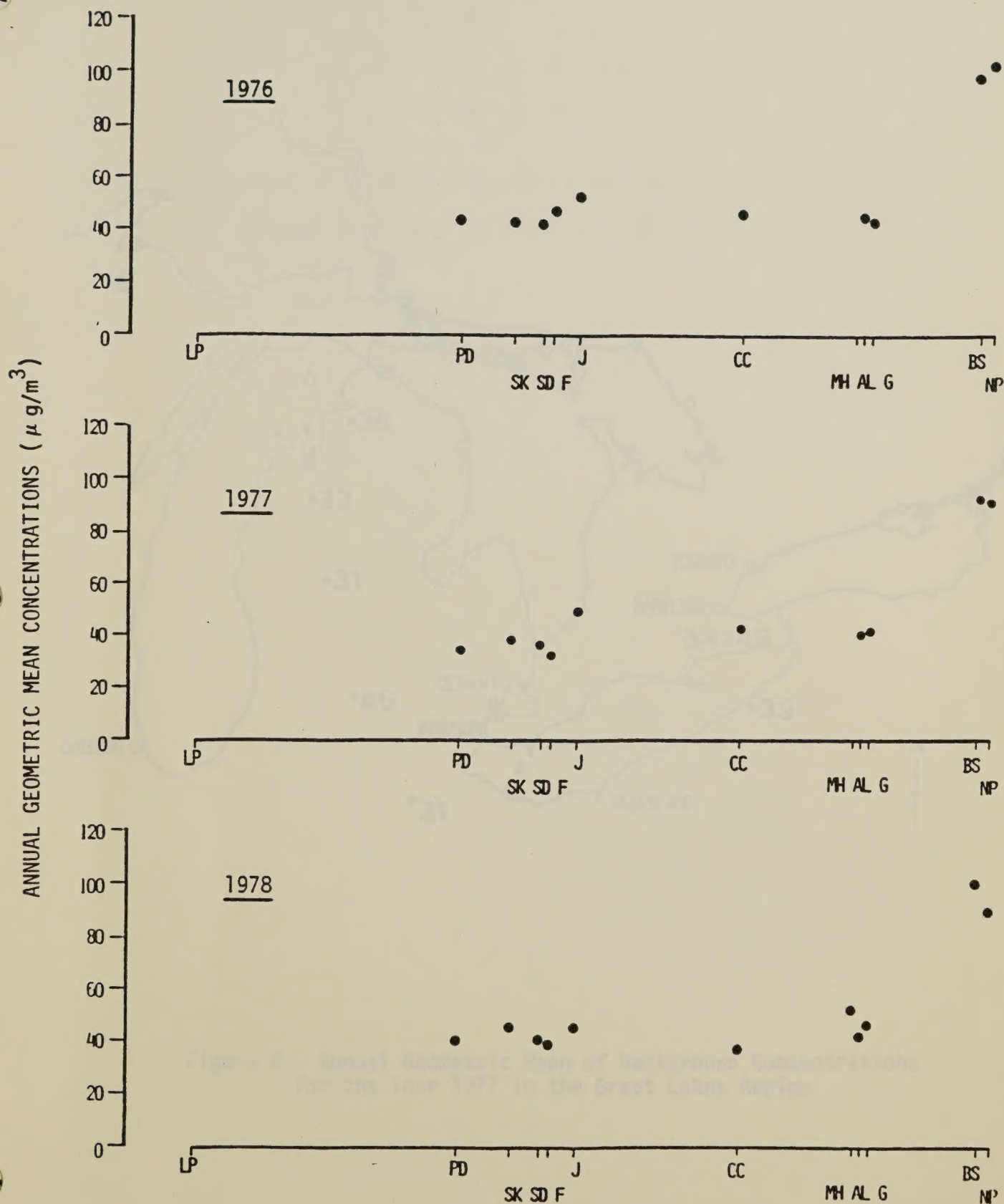


Figure 3. Profile of Annual Geometric Concentrations Across Region for Years 1976, 1977 and 1978

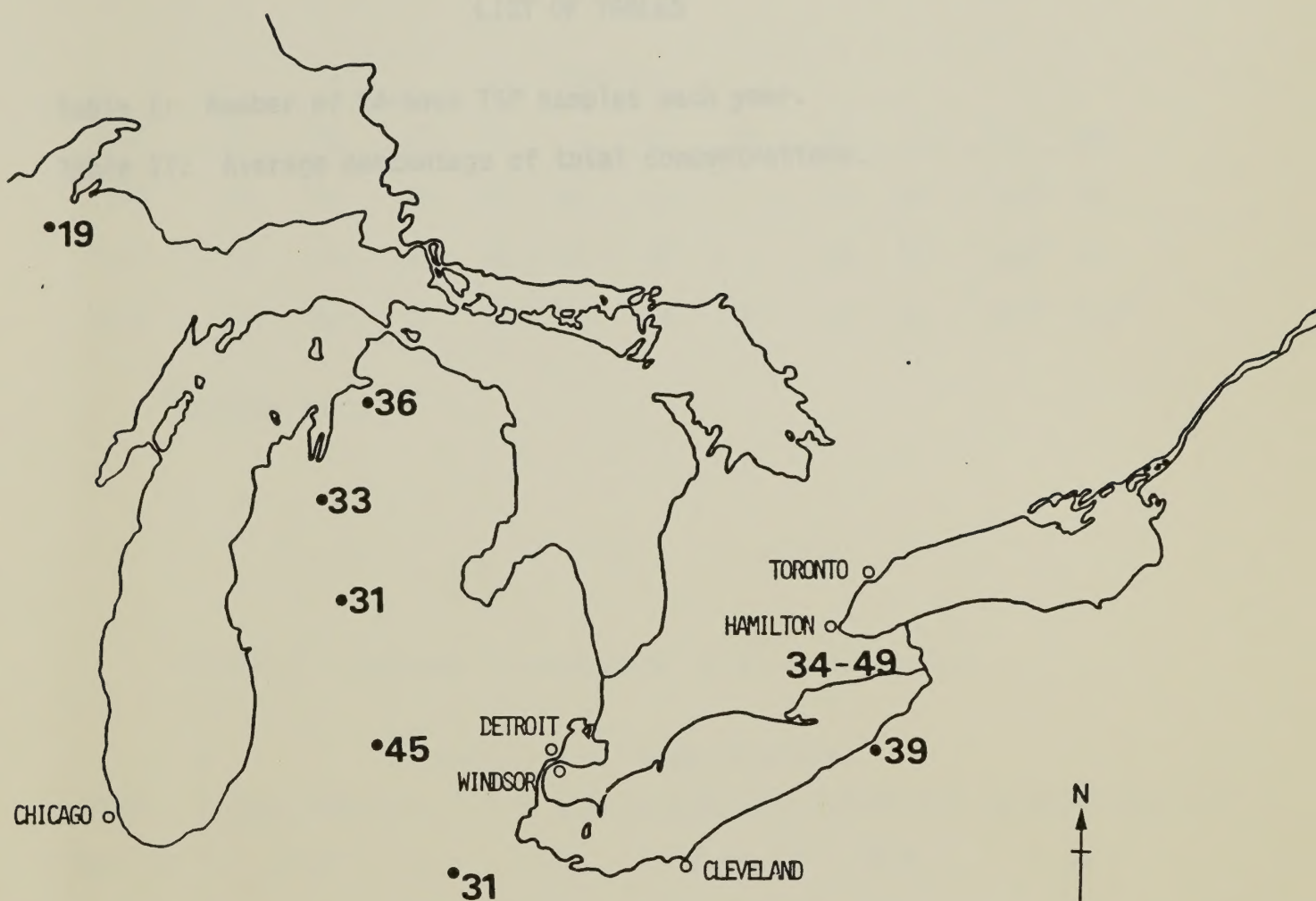


Figure 4. Annual Geometric Mean of Background Concentrations for the Year 1977 in the Great Lakes Region

Table I: Number of 24-hr Total Suspended Particulates Samples Each Year

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Table I: Number of 24-hour TSP samples each year.

Table II: Average percentage of total concentrations.

Year	10-15	15-20	20-25	25-30	30-35	35-40	40-45	45-50	50-55	55-60	60-65	65-70	70-75	75-80	80-85	85-90	90-95	95-100
1976	40	45	55	43	43	43		40	40	112 ^a	54							
1977	37	44	54	38	37	37		38	38	305 ^a	54							
1978	44	53	47	33	37	34	47	50	42	304 ^a	312 ^a							

^aSampled daily

Table III: Average Percentage of Total Concentration

Station	Particle Size Range (microns)				
	Less than 1.1	1.1 to 2.0	2.0 to 3.3	3.3 to 7.0	Greater than 7.0
Urban: 37	24.4	19.2	12.9	16.8	26.7
43	24.2	19.0	11.3	17.2	29.4
Rural: 40	27.4	12.3	14.7	12.3	31.3
2	26.2	13.0	15.7	14.3	31.3

Table I. Number of 24-hr Total Suspended Particulate Samples Each Year

Year	Station										
	PD	SK	SD	F	J	CC	MH	AL	G	BS	NP
1976	45	54	56	43	43	43		40	46	318 ^a	54
1977	37	49	54	38	37	37		39	36	308 ^a	54
1978	43	50	47	33	37	34	47	40	42	304 ^a	318 ^a

^asampled daily

Table II. Average Percentage of Total Concentration

Station	Particle Size Range (microns)				
	Less than 1.1	1.1 to 2.0	2.0 to 3.3	3.3 to 7.0	Greater than 7.0
Urban: NP	24.4	10.2	12.9	16.8	35.7
BS	26.2	10.0	11.2	17.2	35.4
Rural: MH	22.3	12.3	14.7	18.9	31.8
J	21.2	13.0	15.7	18.3	31.8



Ontario

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Environment

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Region

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August 27, 1980

Mr. S. G. Hollowell, Secretary
Environmental Conference
Corporation of the City of Hamilton
Office of the City Clerk
City Hall
Hamilton, Ontario
L8N 3T4

Dear Mr. Hollowell:

As previously requested, please find attached copy of my proposed presentation: "Hamilton Air Quality", to be delivered at the Environmental Conference at Mohawk College on November 14, and 15, 1980. An overhead projector will be required for some of the data. I am looking forward to receive your final program and schedule. Please contact me if anything further should be required.

Yours truly,

Frank Lobroff
for.

K. E. Trent, Chief
Air Quality Assessment
Technical Support Section

Attach.

FOR PRESENTATION AT THE ENVIRONMENTAL CONFERENCE
ENTITLED: "A QUARTER CENTURY OF ENVIRONMENTAL PROGRESS
IN THE HAMILTON AREA AND A BLUE PRINT FOR THE FUTURE"

NOVEMBER 14 AND 15, 1980 AT MOHAWK COLLEGE, HAMILTON

HAMILTON AIR QUALITY

This presentation will consist substantially of three parts. Firstly, information on the source inventory system for Hamilton, used and maintained by the Ministry of the Environment, is presented followed by comments on air quality in Hamilton for the 1979 calendar year, including some observations concerning the local topography and meteorological conditions of significance. Finally, a brief overview of the major remaining industrial problem sources will be given and discussed along with the proposed control programs, with target dates for their implementation.

INVENTORY

The inventory for the Hamilton area was commenced in 1971 and completed in 1972. Its initial purpose was to provide part of the input required for a mathematical air quality predictive model. The inventory has been updated periodically and proven to be a valuable reference source. The area covered by the data comprises approximately 100 square kilometers both below and above the mountain and reaching from Dundas to Stoney Creek.

The inventory distinguishes between point, area and line sources. Point sources are those which have emissions of any one pollutant in excess of 100 pounds per day. Detailed information such as stack height, diameter, temperature, etc. was collected for each of them. The yearly emissions of the following five pollutants are either entered manually or derived by emission factors from the throughput and process involved: sulphur dioxide, oxides of nitrogen, carbon monoxide, hydrocarbons and particulates. Reference is also made to other potential pollutants if applicable. Since sources are identified by east-west and north-south coordinates, to the nearest 100 meters, industrial complexes have often quite a number of separate entries. For Hamilton, a total of 79 companies or institutions were listed originally comprising 114 source entries with a total of 314 emission points.

Lesser sources, classed as area sources, were surveyed in groups for each square kilometer. This includes heating for residential buildings, apartments, schools, public and commercial buildings, small industry and incinerators. Emissions due to shipping, railroads or aircraft operation are also covered under this group. These entries evaluate the previously mentioned pollutants by emission factors for quantities involved.

The third category, line sources, covers automotive emissions. Unfortunately, their evaluation was based on crankcase and exhaust emission factors only. More and more evidence is now accumulating to indicate that re-entrainment of road dust and other fugitive sources are of a far more serious nature than previously suspected. Based on methodologies developed and emission factors derived by an American researcher, Tom Pace, for the Environmental Protection Agency in studies covering a number of U.S. cities, the equivalent particulate emissions for Hamilton

due to re-entrainment caused by automobile traffic are estimated to be greater than all previously inventoried sources combined. While this is spread over the whole Hamilton area, the effect along major roads will be more severe and this represents just one item of the category of fugitive sources.

The accompanying table gives a summary of pollutants from inventoried sources. By consolidating pollution sources into only three categories, ie. major industry, automotive and all others, we arrive at some interesting statistics.

Millions of Lbs. Emitted Per Year - Brackets: Percentage of Total

	SO ₂	Particulate	NO _x	CO	HC
Industrial Sources	46.57(80.6)	21.69(85.1)	32.28(53.2)	39.13(18.0)	25.21(51.5)
Auto Sources	1.31(2.3)	1.75(6.9)	19.90(32.8)	171.26(78.8)	21.25(43.4)
Other Sources	8.89(17.1)	2.04(8.0)	8.54(14.0)	6.80(3.2)	2.51(3.1)
Total	57.77	25.48	60.72	217.19	48.97

The inventoried particulates shown above do not include re-entrainment due to automotive traffic. A rough estimate for this source amounts to over 31 million pounds per year. Inclusion of this fugitive source would

significantly change the respective percentages. The origin or source of this material does of course require further identification.

Because of different dispersion characteristics, a number of other fugitive sources are not represented in the inventory. These include stockpiles, cleared and/or exposed areas, construction, unpaved parking lots and storage areas, and in-plant roads, etc.

AIR QUALITY IN HAMILTON - 1979

The Ministry of the Environment does extensive surveillance work in the Hamilton area. The monitoring network is based on two major stations for the gaseous pollutants supplemented by a number of instruments and devices spread throughout the city. Our objectives are to control man-made emissions to meet ambient air quality objectives which are based on effects on health, quality of life or sensitive vegetation, whichever is most stringent. Monitors are generally sited in areas suspected of experiencing the highest levels of air pollution. Modelling and isopleth evaluation fill in the gaps for the other areas.

The Ministry has been keeping air quality records since 1970. Most gaseous pollutants meet our objectives. The exceptions here are hydrogen sulphide which occasionally and particularly under unfavourable dispersion conditions, shows excesses resulting in odour problems. The other substance of concern is ozone. Although a slight decline occurred in 1979, probably due to a relatively cool summer, our objectives are being exceeded, usually during the summer months. Ozone, a secondary pollutant arising from photochemical reactions in the atmosphere is a

regional problem and elevated levels above the objective have been recorded throughout Southern Ontario and the United States. This pollutant can be transported over long distances from the sources of its precursors and be augmented by locally produced ozone. Most of Southern Ontario's high levels seem to be caused by long range transport from the United States. In Hamilton, concentrations are generally lower than in other localities, probably due to numerous high temperature combustion sources in the city which produce higher levels of nitric oxide, a scavenger of ozone. Hourly objectives for this pollutant are based primarily on vegetation effects, but there are also health concerns. It is known to be associated with respiratory problems and health effects at elevated concentrations.

The main concern in Hamilton as far as pollution is concerned, continues to be particulate matter. Although suspended particulate on its own unless toxic or of a specific nature, has never been shown to be the source of health effects, it is suspected in certain size ranges to act as a carrier for other pollutants which synergistically can have detrimental effects. Suspended particulate levels dropped most perceptively during the 1972 - 75 period as shown in Figure 1 and this improvement is attributable to the control programs instituted by the major industries in conjunction with the Ministry of the Environment. Since 1975 though, levels have remained relatively stable and are still unsatisfactory in many parts of the city, especially near the heavy industry. However, the majority of the city does generally experience acceptable air quality. Soiling index showed a similar decline as suspended particulate, however, dustfall levels have shown no improvement at all during the 1970's and remain well above objectives in a large part of the city. The above classifications refer to different size ranges of particulate matter with dustfall the coarsest and soiling index the finest.

For those not familiar with the measurements techniques employed, here is a brief run down:

Dustfall is that material which settles out of the atmosphere by gravity and is collected in plastic containers during a 30 day exposure time. The material collected is relatively coarse, mostly greater than 10 microns in diameter. A micron is a millionth of a meter.

High volume samplers collect suspended particles in the submicron to 50 microns size range. The sampler is a vacuum cleaner type of affair drawing a larger volume of air through a filter for 24 hours which is then analyzed by our laboratory.

Particulate measurements on an hourly basis (or bi-hourly) are made by coefficient of haze (COH) tape samplers. The measurement is also referred to as soiling index and relates to the finer particles - from submicron to about 10 microns. The sampler draws a low volume of air through a filter and the soiled spot is measured by light transmittance. The measurement is used in the formulation of the air pollution index (API). Generally, the fine size range from 0.1 to 5 microns is considered to be of most concern from a health point of view.

The assessment of 1979 air quality previously presented was based on long-term averages, however, some of the problems encountered in Hamilton are due to short-term conditions, especially during atmospheric inversions. As most people are aware, we employ an Air Pollution Index in Hamilton as well as in a number of other major cities throughout the Province, as a warning system to alert the public to elevated pollutant levels. When the level reaches 32, known as the advisory level and with a

forecast of unfavourable dispersion conditions, major emitters are notified and asked to voluntarily curtail certain operations. At an API of 50, further cutbacks by these sources become mandatory. These alert levels are set with a considerable safety margin before documented health effects have been shown to occur.

During 1979, there were 22 different instances of the API reaching or exceeding 32 and for the first time since 1970, it once exceeded 50. In previous years, there were usually fewer than 10 such occurrences and generally of less severity and duration. This does not, however, represent any deterioration of industrial emissions which were in fact essentially unchanged from 1978, but reflects a greater number of times when poor atmospheric dispersion conditions prevailed (eg. low wind speed and/or the presence of an inversion). The majority of the incidents occurred in the spring and fall and were related to inversions formed when cool air blew off the lake often in combination with frontal inversions associated with storm systems.

GEOGRAPHIC SETTING AND METEOROLOGICAL CONSIDERATIONS

Hamilton or at least the lower city forms a bowl being surrounded by the Niagara Escarpment and is open to the northeast to Lake Ontario. The dispersion of pollutants in the atmosphere is restricted when an inversion (the increase of air temperature with height) is present in the lower atmosphere. Concentrations on the ground increase when the volume of air in which mixing and dilution of the pollutants can occur is restricted.

There are three types of inversions which are of prime interest to the situation in Hamilton: advection inversions, frontal inversions and subsidence inversions.

The prime cause for advection inversions in Hamilton is the flow of cool air from over the lake into the city. This layer of cooler air is usually high enough to extend over the Escarpment. Warmer air coming from the south over-rides the cool air in the city thus forming the inversion interface. Mixing within the stable cool air is severely restricted and hence results in increased concentrations. In addition, the wind off the lake is usually quite weak. As a result, normal industrial emissions drift over the city and begin to build up due to the lack of ventilation. The described situation varies in intensity depending on the height of the inversion layer which can at times be quite low.

Frontal inversions occur along the boundary of warm and cold air masses. In the case of the warm frontal inversion, a warm air mass overtakes and over-rides a cold air mass forming a gently sloped inversion layer that may extend over large distances. Because the winds generally associated with warm fronts in Hamilton often blow from the east across the lake, warm frontal inversions are sometimes strengthened by the advection effect.

Subsidence inversions are caused by the slow descent of air from higher elevations in the center of high pressure systems. This descending motion causes the air in an elevated layer to be compressed thereby increasing its temperature and forming an inversion layer aloft. Because these inversions are most often formed in slow-moving or stationary high pressure cells, the air mass accumulates a high burden of pollutants.

This type of system can often linger for a considerable length of time and generally covers relatively large areas.

In review, despite significant reductions in pollution levels from the early 1970's, the concentrations of particulates remain unacceptable in many parts of the city. Although inventoried industrial process emissions have decreased moderately over the last five years, the effect on measured pollutant levels during that period has been negligible. This indicates that apart from the remaining process emissions (for some of which abatement technology must still be developed), other pollution sources which so far have received little attention may have to come under control. These are the so called fugitive sources which are generally low level and non-stack emissions which have often been ignored. They can be either industrial or non-industrial in nature such as major material transfer activities, blow off from stockpiles, unpaved areas or roads, roads in poor repair, excavation and construction activities, material handling and road traffic. Other important sources are apartment and institutional incinerators.

STUDIES IN PROGRESS

To identify the type and origin of the dust particles in Hamilton's air including the effect of road dust and its re-entrainment by wind and traffic, a study under the guidance of the Ontario Research Foundation, co-operatively funded by three levels of government and industry, is presently in progress.

The basis of the study is the fact that during recent years, improvements in air quality have not been proportional to abatement efforts by

government and industry. It appears that there is a limit to further air quality improvements which can be achieved through control of traditional sources and that abatement measures which could be undertaken are becoming increasingly costly as well as sometimes high in energy consumption and decreasingly efficient. The study is expected to result in sound scientific information on the proportion of air pollution attributable to industrial and non-industrial sources as well as to conventional and fugitive sources. This should provide a basis for determining the most cost-effective control strategies at our disposal.

Another major study, funded by different levels of government is presently proceeding under the guidance of researchers from McMaster University. It is attempting to determine, by extensive respiratory tests on Hamilton school children, a relationship between air quality and health symptoms. Other factors such as the indoor environment which might affect the children's health, will be considered in the evaluation. It is hoped that the results of the study will provide evidence in establishing sound criteria, standards and indices for ambient air quality based on actual health effects.

HAMILTON INDUSTRIAL PROBLEMS

As far as control technology is concerned, the majority of process equipment at a steel mill has a long useful life often of several decades. With this in mind and considering the relatively recent concerns with respect to the effects of industrial emissions on the environment, it must be realized that it has been necessary to develop new technologies in order to retrofit old equipment with pollution control systems that will

enable emissions to meet environmental standards. In fact, this development is still underway and economic considerations often have a major bearing on the practical application of various technological options.

The status of control development and know how for the various processes within fully integrated steel mills varies. The following is a rough summary for the various activities.

Coke Ovens

Coke ovens are a source of particulates, odours and smoke but over the years emissions of these pollutants have been reduced. Improvements in charging emission controls have been made by using sequential charging cars employing jumper pipes to improve suction and enhance fume removal to the collection main. On more modern batteries, double collection mains are used to provide better suction for the control of emissions during charging and gas removal during coking.

Pushing emissions have been controlled on fairly new existing batteries by constructing sheds and treating the collected gases and dust in an electrostatic precipitator.

Coke quenching is also a source of coke dust. Technology applied to controlling these emissions has not made any major progress in recent years. Control is achieved by using baffle plates at the top of the quench towers. Some improvement in the efficiency of the baffle plates has been made at new facilities.

Blast Furnaces

The major source for emissions at the blast furnace is the tapping operation. Except in very small cast houses, total building evacuation is not economically viable. Control of these emissions in a retrofit situation, is still under development. Placing hoods at strategic locations is one area being investigated, but this has to be custom designed to each blast furnace and problems arise with access for existing equipment. Advanced technology at new mills uses tilting runners and local hoods.

Steel Making

The area that cause the most complaints due to "red smoke" are the steel making facilities. With both of the open hearth shop and the basic oxygen furnace shop, the main gas produced in the refining process is collected and treated by either electrostatic precipitators or venturi scrubbers. Periodic emissions can result from these facilities due to volumetric overloading or in the case of the scrubber, inadequate pressure drop.

The roofs at the steel making shops are equipped with "elephant ear" type roof monitors. Emissions from these roof monitors can occur from charging operations and in the case of the open hearth, from reversals and tapping operations. These emissions can exceed the opacity standards.

In the basic oxygen furnace shops, auxiliary collection hoods are employed to capture the majority of these fumes. With the open hearth shop, technology has not been developed to control these emissions economically, however, the open hearth steel making process has now been generally superseded by the basic oxygen process.

Coke Handling

Coal storage piles have been a significant source of coal dust emissions in the past. Extensive research has been conducted in methods of control and subsequently employed in the field. Constant wetting of the piles and roadways is the most important factor in coal dust control. In addition, piles are specially shaped and sealed with crusting agents to minimize wind blown dust.

Odour Sources

Odour sources from the steel industry have been a periodic source of complaints for a number of years. However, positive identification of specific odour sources has been difficult. The measurement of a particular chemical compound is relatively simple, but assessing the odorous potential of a mixture of compounds is more difficult. Odour thresholds are often below detectable limits of analyzers for specific compounds. However, recently methods have been developed to assess odours by using an odour panel. A sample of the odorous gas is diluted until it is barely detectable and the amount of dilution from a known volume of sample enables a number of odour units to be assigned.

A survey has been conducted at one steel mill to positively identify sources of odour and control of these sources is currently being evaluated.

In summary, it can be stated that existing steel mills have specific problems with regard to airborne contaminants from their various operations. Many of these problems are associated with age of equipment

and the development of economically viable technology and their proven application to control emissions.

The best equipment, however, can fail and considering the proximity of the sources to each other in Hamilton's industrial area, a potential for unacceptable emissions exists at all times.

Finally: what is going to be done about it?

Surveys of both air and water emissions from Stelco and Dofasco were completed in early 1980. Control Orders, based on the recommendations and the survey reports were then drafted. Open houses and public meetings were held in June for Dofasco and in September for Stelco.

Major requirements for the next few years contained in the Dofasco Control Order were as follows:

1980:

1. Submit a binding schedule for controlling standpipe lid leakage from No. 6 coke oven battery.
2. Increase fume collection efficiency for dekishing station.
3. Submit a binding schedule for minimizing casting emissions from No. 4 blast furnace.

4. Report measures to be taken to reduce road and yard dust.

1981:

5. Rebuild No. 1 coke plant.
6. Submit a binding schedule for reducing charging emissions at No. 2 coke plant.

1982:

7. Install a "single spot" quench car at the No. 2 coke plant and submit a binding schedule for controlling pushing emissions.

1983:

Implement the remaining scheduled items.

The Stelco Control Order contains the following major requirements for the near future.

1980:

1. Assess pushing fumes suppression spray system for Nos. 3, 4 and 5 coke oven batteries.
2. Control charging emissions for Nos. 4, 5 and 6 BOF's.

3. Repair main exhaust system in BOF shop.

1981:

4. Submit a program for pushing fume control if the assessment required under item No. 1 proves unacceptable.
5. Report on methods to minimize coke oven door leakage.
6. Control charging emissions from Nos. 4 and 5 coke oven batteries by installing No. 10 larry car.
7. Submit a schedule for blast furnace cast house emission control.
8. Evaluate control of fugitive emission sources within the open hearth shop.

1982:

9. Upgrade charging emission control on No. 6 coke oven battery.
10. Submit a program for controlling open hearth roof monitor emissions.

Implementation of these orders by Dofasco and Stelco will bring their suspended particulate emissions within the requirements of Regulation 15 of The Environmental Protection Act, 1971 - namely less than 100 micrograms per cubic meter, half-hour average concentrations at any point of impingement outside plant property, by mathematical assessment.

Actual air quality surveillance by the Ministry is an on-going task, and we hope that the proposed controls in connection with other measures will improve Hamilton's air quality to acceptable levels. However, as mentioned before, there will always be days when the combination of meteorological conditions and upsets in processes in conjunction with some other factors will result in less than satisfactory conditions.

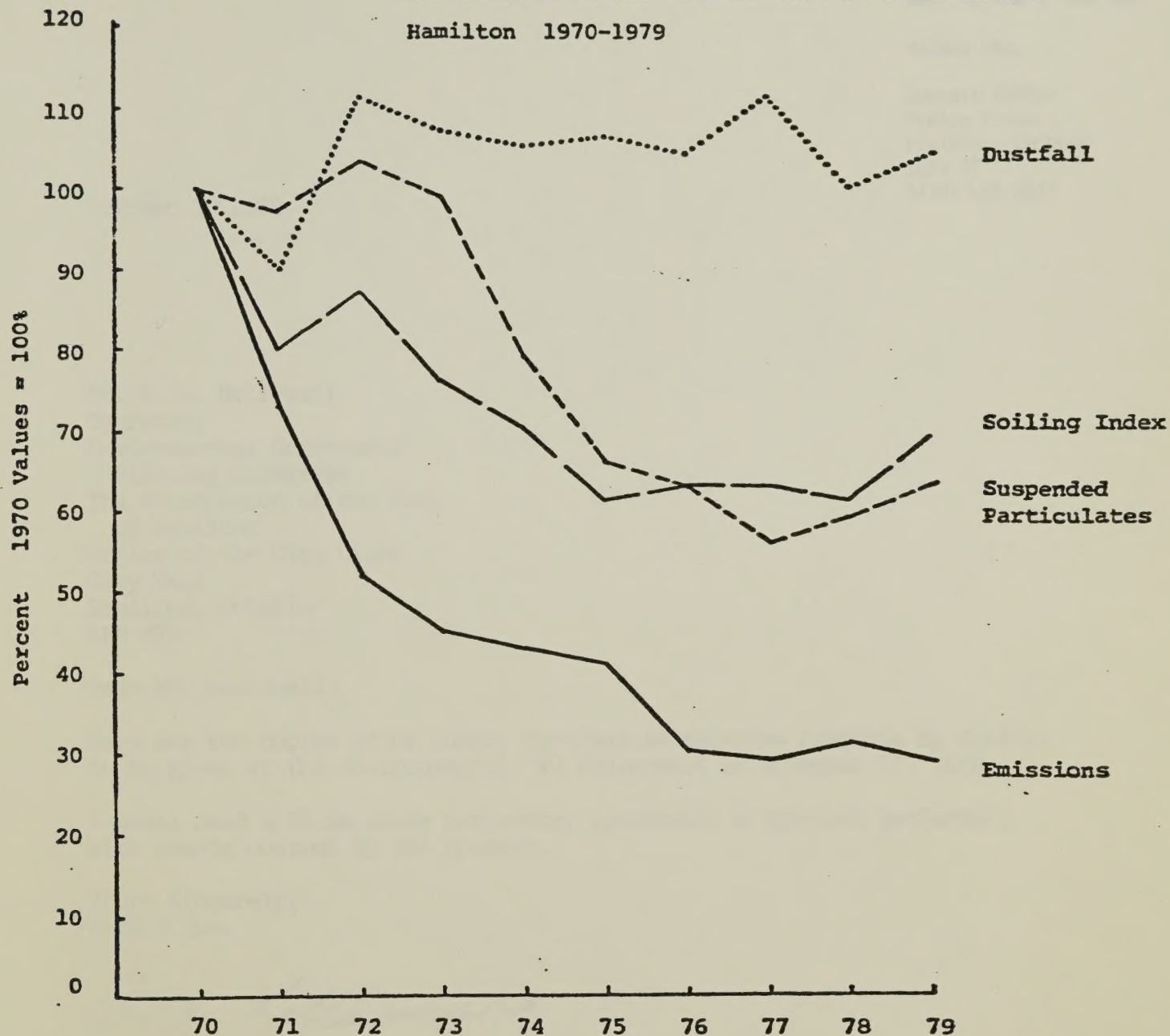


Suspended Solids	321	327	130	130	104	85	81	75	73	62	µg/m³
Suspended Particulates	8.4	8.5	16.2	12.2	9.8	10.0	8.3	10.4	9.8	9.8	µg/m³
Total Hydrocarbons	.34	.43	.47	.41	.38	.35	.34	.38	.33	.31	µg/m³
Carbon Monoxide	34	41	23	24	24	30	27	35	25.5	18	ppm

FIGURE 1

Particulate Trends vs Estimated Total Emissions

Hamilton 1970-1979



Suspended Particulates (7 station)	131	127	135	130	104	86	83	73	77	82	$\mu\text{g}/\text{m}^3$
Dustfall (17 stations)	9.4	8.5	10.4	10.1	9.9	10.0	9.8	10.4	9.4	9.8	$\text{g}/\text{sq.m}/30\text{days}$
Soiling Index (7 stations)	.54	.43	.47	.41	.38	.33	.34	.34	.33	.37	$\text{COH's}/1000\text{ft.}$
Institutional & Industrial Emissions	56	41	29	25	24	23	17	16	17.5	16	10^6 lbs/year

stelco

Stelco Inc.

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L8N 3T1
(416) 528-2511

October 1, 1980

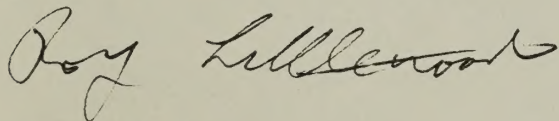
Mr. S. G. Hollowell
Secretary
Environmental Conference
Planning Committee
The Corporation of the City
of Hamilton
Office of the City Clerk
City Hall
Hamilton, Ontario
L8N 3T4

Dear Mr. Hollowell:

Here are two copies of my paper, *Particulate Emission Controls by Stelco*, to be given at the Environmental '80 Conference on November 15, 1980.

I shall need a 35 mm slide projector, preferably a Carousel projector, with remote control by the speaker.

Yours sincerely,
Stelco Inc.



R. Littlewood
Senior Technical Advisor
Research & Development

RL:CJJ
Encl.

Copy to: Mr. A. V. Forde

PARTICULATE EMISSION CONTROLS BY STELCO

*Roy Littlewood
Senior Technical Advisor
Research and Development Department
Stelco*

Hamilton is Canada's major steel manufacturing centre. Over half the nation's steel is made here and Hamilton is home to Canada's two largest steel companies, Stelco and Dofasco, as well as smaller mills and foundries.

Such a concentration of industry ensures Hamilton's economic prosperity, but also brings with it a concern for potential air quality problems. Over the years, both Hamilton's citizens and its industries have been sensitive to these problems. This conference, celebrating a quarter century of environmental progress in the Hamilton area, testifies to our many years of concern.

The steel industry is a potential source of a number of air pollutants - particulates (dust) and gases, such as carbon monoxide, sulfur oxides, and nitrogen oxides. This same list of pollutants is common to many of man's activities. Other well-known sources of these contaminants include, for example, automobiles and residential heating systems, but the steel industry has been especially concerned because of the large scale of its operations and because its emissions are concentrated over a relatively small area of the city.

This paper focuses on the reduction of particulate emissions from Stelco. Hamilton, like many large cities, shows high levels of particulates on monitoring instruments at some locations, and particulates have been the Ministry of Environment's main air quality concern. A companion paper by Dofasco covers control of some gaseous pollutants also. Both companies, of course, have programs designed to reduce all these emissions, but we are presenting the information in this way to avoid overlap and needless repetition, as the problems faced by the two companies and the solutions adopted, are similar.

In this paper, we shall review the trends in air quality in Hamilton, and show how efforts by industry have cut particulate emissions by more than two-thirds since 1970. We shall review Stelco's contribution to this achievement and describe some of the novel techniques which Stelco has developed.

Hamilton's Location and its Relation to Air Quality

Hamilton has an unusual geographic setting. It is located at the western tip of Lake Ontario, with the 100 m-high Niagara Escarpment forming a bowl shape, open to the lake to the east (figure 1). These features, and their effects on wind patterns and other meteorological factors, have fascinated geographers for many years. Hamilton's unique setting has a strong influence on air quality in the city and it is important to understand this influence.

The prevailing winds are dominantly from the west and southwest. The Dundas Valley funnels these winds across the lower city, north of the Niagara Escarpment. The heavy industrial district is concentrated on the south shore of Burlington Bay, with the central business district southwest of this area. Both districts are sources of particulate matter; in addition, the steelworks of the heavy industrial district are large heat sources.

Hamilton is located so that its emissions are usually carried out over the lake by the prevailing winds. The heat generated by the steelworks helps to disperse emissions arising from the city and its industries high over the lake.

Only on occasions, when cool lake breezes blow from the east, are industrial emissions carried over the city. Under these circumstances, high pollution levels may occur when cool air becomes trapped below a warmer layer, locking in all emissions (figure 2). These "inversion" conditions are common in Hamilton in the spring and fall. Under such "inversion" conditions, a distinct pall is visible over cities because pollutants cannot disperse, and high levels of pollution are reported; for example, high values of the pollution index.

Particulate Levels in Hamilton

Air Quality in Hamilton has improved significantly since 1970, according to the Ontario Ministry of Environment (MOE) 1979 Annual Report. But the main concern continues to be particulate matter. Suspended particulate levels dropped most perceptively during 1972-75 (figure 3), and this improvement is attributed by the MOE to the control programs instituted by the major industries. Since 1975 though, levels have remained relatively stable and are still unsatisfactory in some areas of the city. Suspended particulate levels in city air have fallen by only forty percent, compared with a drop in emissions from industry

Hamilton has an unusual geographic position. It is located at the center of the Lake Ontario basin, and the city is situated on the western shore of the lake. The city is located on the western shore of the lake, and the city is situated on the western shore of the lake. The city is located on the western shore of the lake, and the city is situated on the western shore of the lake.

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All things considered, the city is located on the western shore of the lake, and the city is situated on the western shore of the lake. The city is located on the western shore of the lake, and the city is situated on the western shore of the lake. The city is located on the western shore of the lake, and the city is situated on the western shore of the lake.

and institutions of 70 percent. This discrepancy suggests that factors other than industrial emissions may be responsible for the high values, and this impression is reinforced by the fact that dustfall has *not* decreased (figure 4). Studies reported at this conference suggest that a large proportion of suspended particulates in downtown Hamilton arises from dust thrown up by road traffic, which could explain why suspended particulate levels have not fallen as much as might have been expected from the drastic reduction in industrial emissions. We may be reaching the point of diminishing returns in terms of environmental benefit to the community.

Reduction of Particulate Emissions by Stelco

Stelco has had a pioneering program for the reduction of particulate emission for many years. Our first major environmental control installation was in 1928. In a technical breakthrough, Stelco became the first company in North America to collect, clean and recycle blast furnace gas rather than discharge it into the atmosphere, with its polluting particulates and carbon monoxide - a common industrial practice at the time. Stelco was also the first Canadian steelmaker to put engineers and technicians to work *full-time* on environmental quality control problems, and for two decades such groups of technical people have been making major steps in environmental control.

As a result of their efforts, particulate emissions from process sources at Stelco's Hilton Works have shown a steady downward trend, in spite of increasing production. The amount of steel produced has risen from 4.7 million tons per year in 1970 to nearly 5.4 million tons per year, yet total emissions have been *reduced* by 75 percent (figure 5). This is a remarkable achievement and the reduction in emission rate per ton of steel is even more impressive. Figure 6 shows Stelco's record in reducing the rate of emissions per ton of steel processed, from 1960 to 1979. Emission rate per ton of steel processed in 1979 was *one-tenth* of the 1960 value, a technical accomplishment in which Stelco's environmental control engineers can take pride.

This success in reducing emissions was made up of many steps, some large, some small, and involved the ideas and efforts of many people. The installation dates of some major environmental control equipment are indicated in figure 6 - electrostatic precipitators on oxygen-blown Open Hearth furnaces (1961-64), baghouses on the sinter plant (1970) and the shutdown of number two Open Hearth shop (1971). The phasing-out of No. 2 Open Hearth shop and control of

the Sinter Plant discharge have been the two most important reductions in particulate emission since 1970,

We are now capturing 98 percent of the potential particulate emission from Hilton Works.

Some Examples of Control of Particulate Emissions

Coal Dust

Stelco must store over one million tons of coal at the end of each shipping season, to sustain operations during the winter. The coal is not burned as a fuel. It is made into coke for use in the blast furnaces, and coal for the coking process has to be carefully blended to obtain the right properties. Up to seven different coals are needed, and these are stored in separate storage piles, over a total area of about 83 acres.

Blowing coal dust can be a problem in dry, windy conditions, but painstaking research and a combination of common sense and innovative steps have brought the problem under control.

The coal arrives at Hamilton in self-unloading vessels. A conveyor deposits the coal in a conical pile on the dock. Water is continually sprayed on the coal to limit dust blow-off during the unloading process. A bulldozer is used to level this conical pile and large mobile scrapers transfer the coal to the storage piles, which may be up to 1100 ft in length. A similar process, in reverse, is used during the ex-stocking process when the coal is removed from the storage piles and taken to the Coke Ovens.

In high winds, coal dust may be blown about:

- when the coal drops from the conveyor to the conical pile,
- by general wind erosion from the conical pile,
- during the period the scraper is travelling over the storage piles or the arterial roads, and
- by general wind erosion from the long-term storage piles themselves.

Several of these problem areas were recognized many years ago and solutions were implemented to control the problems. During unloading:

- water sprays are directed into the loading coal-stream and conical piles,

The first thing I noticed when I stepped out of the car was the cold. It was a sharp contrast to the warm blanket of the car. I shivered slightly, but then I remembered that this was just the beginning of the journey. I took a deep breath and stepped out onto the pavement. The air was crisp and clear, and I felt a sense of freedom. I walked towards the building, my steps light and sure. The sun was shining brightly, and the world around me seemed to be in a state of perfect harmony. I felt a sense of peace and tranquility, and I knew that this was the start of something great.

John F. Kennedy
President of the United States

Dear Sir,

I am writing to you today to express my appreciation for the work you have done for the country. Your dedication and hard work have been a source of inspiration for many people. I am proud to have you as a member of my administration. I believe that your skills and experience will be a great asset to the team. I am confident that you will continue to make significant contributions to the success of our nation. Thank you for your commitment and for the service you have provided. I look forward to working closely with you in the future.

I am sure that you will find this a challenging but rewarding experience. I will be supporting you every step of the way. Please do not hesitate to reach out to me if you need any assistance or guidance. I am committed to your success and to the success of our country.

The first step in the process is to identify the problem. Once the problem has been identified, the next step is to develop a plan of action. This plan should be based on a thorough understanding of the problem and the resources available. It should also take into account the needs and expectations of the stakeholders involved. Once the plan has been developed, the next step is to implement it. This involves a series of steps, including identifying the key tasks, assigning responsibilities, and setting deadlines. It is important to monitor progress and make adjustments as needed. Finally, the last step is to evaluate the results. This involves comparing the actual outcomes with the expected outcomes and identifying areas for improvement. By following these steps, you can ensure that your project is completed successfully and that your goals are met.

In high school, I was very active in my school and community. I was a member of the student body and the school sports team. I also worked as a volunteer at a local charity. I was a very hardworking and dedicated person, and I was always striving to be the best I could be. I was a very popular person, and I had many friends. I was also a very good student, and I was always getting good grades. I was a very well-rounded person, and I was always looking for new challenges. I was a very ambitious person, and I was always setting high goals for myself. I was a very determined person, and I was always working hard to achieve my dreams. I was a very successful person, and I was always making a difference in the world.

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- the free-fall height of the coal is minimized by lowering the conveyor as much as possible, and
- a protective enclosure shields the falling stream of coal from the wind.

While these precautions are satisfactory under normal atmospheric conditions, in extremely high winds unloading operations are stopped.

In order to minimize dusting while the scrapers move along the roads and storage piles, tanker trucks are used to spray water in the summer. In the winter these same trucks are used to spray waste oil onto the roadways. These specially-designed tankers can spray 10 000 gallons of water in 15 minutes to any area of the coal piles.

At the end of the shipping season, the piles are coated with a binding agent which seals the surface and controls dust during the winter when water cannot be sprayed.

Research has included construction of a model of the complete site including the terrain, buildings, conveyors, stacks, the unloading docks and surrounding water area, as well as separate models of the coal piles. The model of the site was used to determine the complex flow pattern of the wind. Several models of the coal piles were used in assessing, in detail, the effect of orientation and shape of the piles.

Tests with the models revealed that aerodynamic shaping of the coal piles and orientation along the direction of the prevailing wind were important factors. As a result, Stelco completely reorganized its coal-handling operations to conform with the research consultants' recommendations. We believe we were the first company in North America to aerodynamically design a whole coal pile storage operation on such a large scale.

The research also indicated that porous fences, similar to snow fences, were an effective way of preventing wind erosion of coal dust, particularly where coal was being removed from the leeward side of the stockpile. Wind tunnel tests were used to assist in choosing the best sealing agents for the winter cocooning.

The combination of binding agents, water sprays, oiling, wind fences, coal pile shaping and orientation, applied by conscientious operators now keeps coal dust under control.

The first half of the year is devoted to
by January the Government has only a possibility
of a considerable increase in the falling prices
of coal from the mine.

While these possibilities are self-evident, other points
concerning coal, in connection with the following
operations are shown.

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and during the winter when there is no shipping.

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Coke Ovens

Controlling emissions from coke ovens is one of the most troublesome environmental problems faced by the steel industry worldwide.

The coke ovens manufacture coke to feed the blast furnaces making molten iron. Coal is baked in large, slot-shaped ovens which are tall, narrow chambers arranged side-by-side in "batteries" (figure 7).

Carefully-controlled blends of coals are poured, or charged, into each of the ovens from the top, by a special railcar called a "larry car". The escape of emissions - coal-dust and coal-smoke - during charging, before the lids can be replaced on the oven, has been a major problem.

Stelco pioneered the use of water-scrubbers mounted on the larry car in 1968, when no other control technology was available. Although emissions were reduced, there were operating problems and our scrubber-equipped car is now used only as a standby for improved equipment.

As a result of this experience, Stelco decided to participate in a \$2.3 million joint venture for the development of a new charging process, under the auspices of the American Iron and Steel Institute. Three new charging cars have been fitted on the coke oven batteries at Hilton Works, with a further one under construction. Their purpose is to keep the charging fumes in the oven, by feeding coal in a controlled fashion so that the smoke and dust can be sucked into the oven's gas collection system. By the way, each of these new larry cars costs about \$2-1/2 million.

Coal is baked in the oven for about 18 hours to make coke. When coking is complete, end doors on that oven are removed and a ram pushes out the red-hot coke into a waiting railcar - the "quench car". Gases and dust rise from the hot coke during pushing and the railcar of coke is rushed to a quenching tower to be cooled with water.

Control of emissions during coke pushing is an even more difficult problem. Our first approach was to bake the coke for a longer time to reduce emissions and this was a partial solution.

Any method of collecting the emissions is an expensive proposition. At Stelco, we tried to achieve a complete solution to the problem by erecting an immense hood to collect and clean the emissions from our newer batteries. This ventilated building or shed is the width of a major highway,

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the height of a nine-story building, and longer than two football fields placed end-to-end. It completely covers the entire side of two coke oven batteries (156 ovens) and cost \$7.2 million.

Smaller, mobile hoods of various designs have been developed and tried in various parts of the world. They are particularly successful when designed as part of a newly-built coke-oven battery and our new coke ovens at Lake Erie Works have this type of control. Mobile hoods have given poor results on older coke-oven batteries, so we have been experimenting with systems of water sprays at Hilton Works, based on a technique developed by a steel company in the United States. This is giving promising results, and if tests are successful, its use will be extended.

Steelmaking Furnaces

When Stelco pioneered the use of oxygen in open hearth steelmaking in the late 1940's, we realized, along with those working on similar processes in Europe, that a disadvantage of the use of oxygen was the copious amount of red oxide fume generated. The new processes could not be used on a large scale until means were found of capturing this red smoke.

As new technology of fume collection developed, it allowed us to apply oxygen gradually to our steelmaking furnaces. The first fume collectors, or electrostatic precipitators, were installed in 1961 and installations were added to more furnaces in subsequent years up to a total of nine electrostatic precipitators. In 1973, we shut down one of our Open Hearth shops which, although it had not used oxygen, was still a source of particulate emissions. It was replaced by a new oxygen steelmaking shop, with a further nine electrostatic precipitators.

At the present time, we are collecting about 350 tons per day of steelmaking fume. About 99 percent of the dust emitted in steelmaking is captured.

A Remaining Problem

We are proud of the fact that we have reduced our rate of emission of particulates by 90 percent since 1960. We have been successful in capturing most of the major emissions, but there are some that are difficult to catch, whatever hoods and ducts are used. These difficult-to-catch dribbles

The height of a mine-shaft building, and longer than the
vertical shaft ground and end. It is, usually, more
the width of the shaft than the height. This means, and
cost \$7.5 million.

Earlier, mobile kinds of various designs have been developed
and used in various parts of the world. They are mobile
because they are designed as part of a mobile unit, and
battery and are not connected to the shaft. They have this
type of control. Mobile units have given more freedom in
their operation, but, as we have seen, they are not
with systems of water supply as with the shaft. They are on a
remote location, and a steel structure is not needed. This
is the main reason for their use, and it is also very successful.
It will be successful.

Technical Summary

When the shaft is designed, the use of shaft in open shaft
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operation in shaft operation in shaft, and a shaft
to the use of shaft and the shaft is not of the shaft
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to be able to use shaft in the shaft operation. The shaft
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At the present time, the shaft is not used as a shaft. The shaft
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Summary of the Problem

We are aware of the fact that we have a problem. The problem
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that we have a problem. The problem is the fact that we have a problem.
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that we have a problem. The problem is the fact that we have a problem.

are called "fugitive emissions" - or "the ones that get away!". They often arise within a building from occasional discharges or surges of smoke around a collection hood, and result in visible emissions from roof ventilators for short periods of time.

These fugitive emissions from Stelco's operations are unsightly and a nuisance, yet their effect on community air quality is small. They are a vexing problem, because with present technology they are outrageously expensive to capture, both in money or in energy terms. At present, it appears that only in new facilities, where equipment can be tailor-made, can fugitive-emission reduction be attained at reasonable cost, such as at our new operations at Lake Erie Works.

The frustrating nature of our problem is similar to that of "fugitive emissions" from road traffic and wind-blown dust mentioned in other papers in the Conference, with the important difference that the effect on community air quality of Stelco's fugitive emissions is small.

In closing, I would stress that Stelco environmental people are proud of their efforts and their successes. These efforts will continue in the years to come.

Figure 1: Map of the Hamilton Area

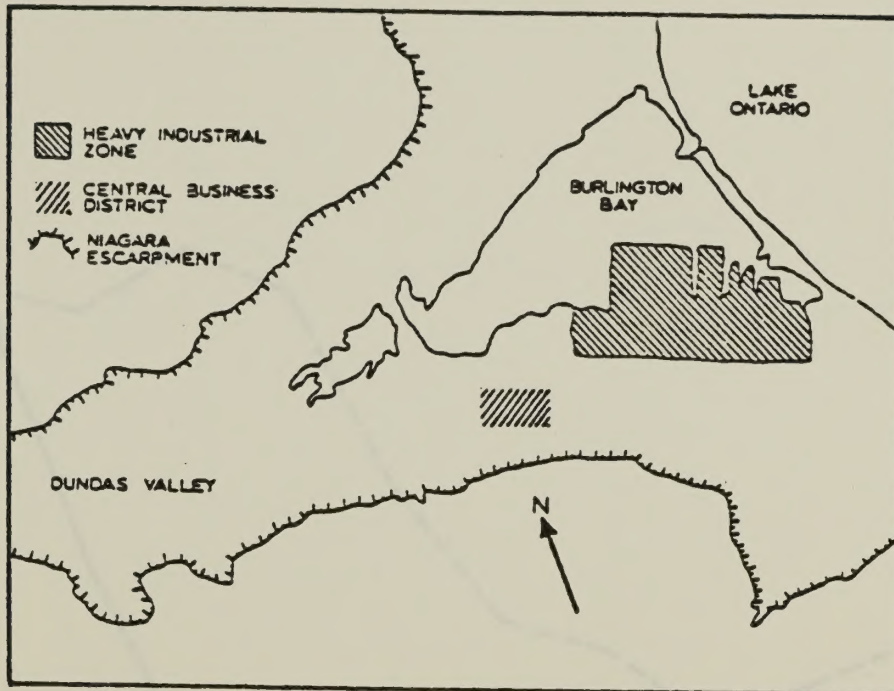


Figure 2: How Inversion Conditions Put a "Lid" Over Hamilton, Preventing Dispersion of Pollutants

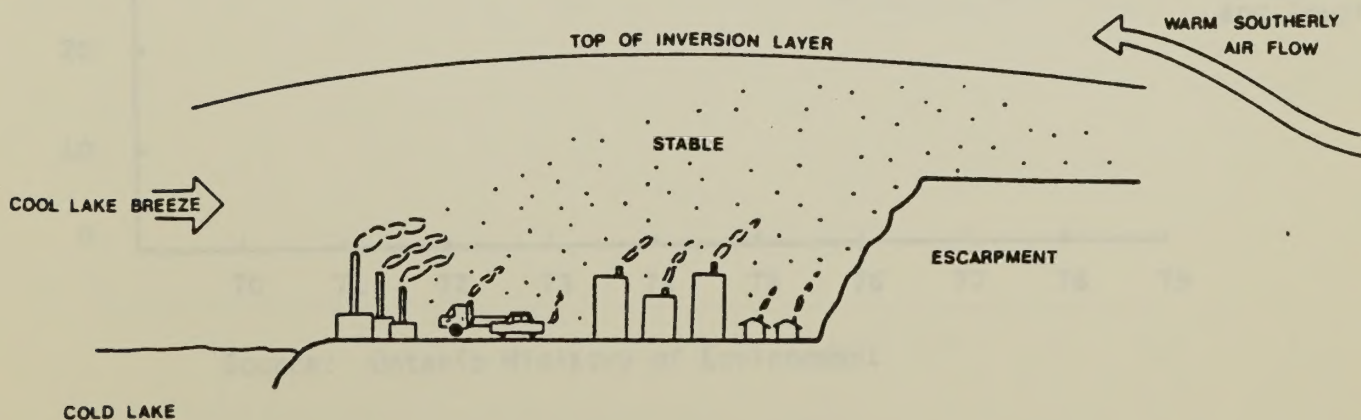


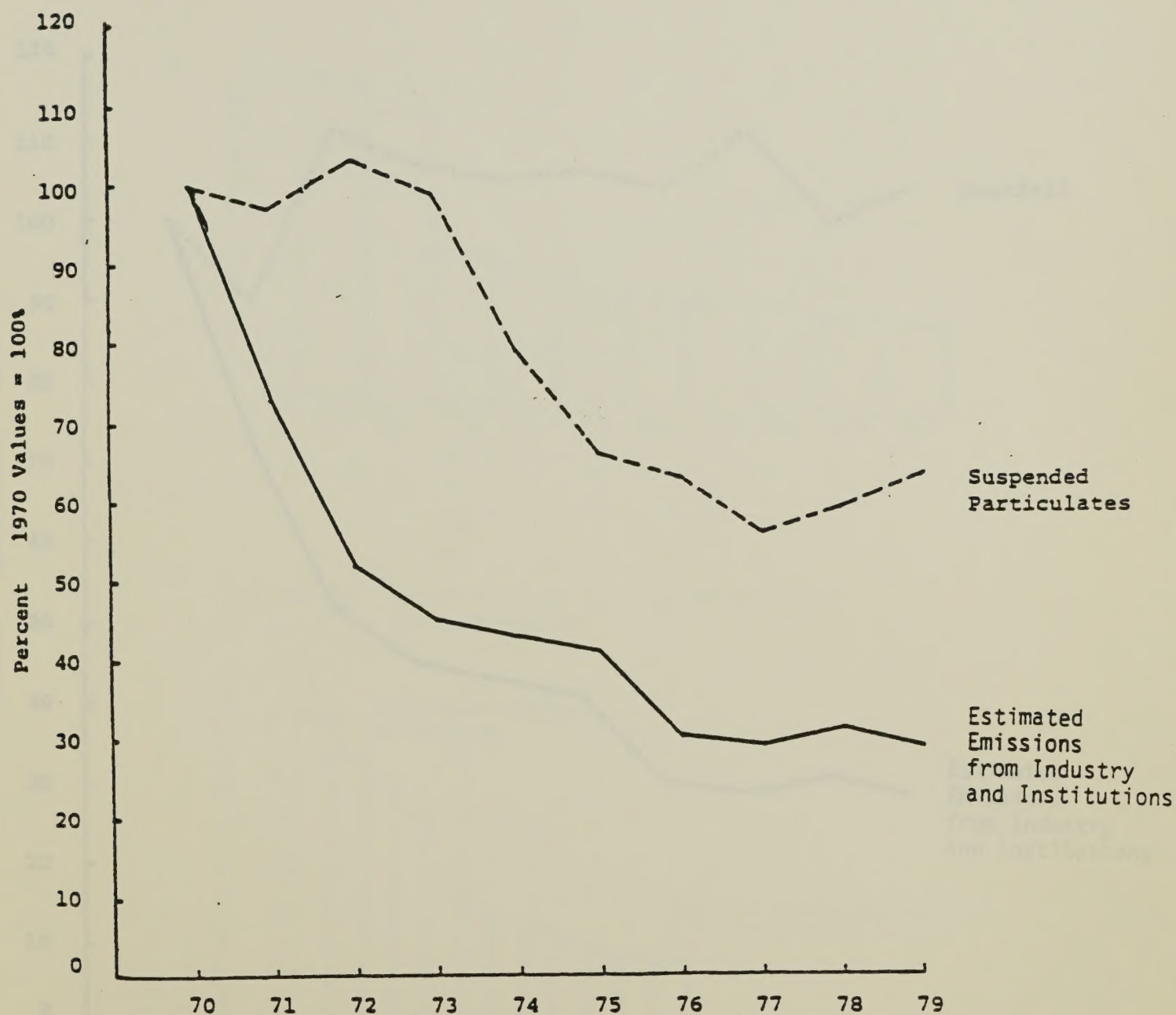
Figure 1 Map of the Hamilton Area



Figure 2: How Intersecting Contours at a "15" Over Hamilton, Tennessee, Represented the Distribution of Political



Figure 3: Suspended Particulate Trends vs Estimated Total Emissions
Hamilton 1970-1979

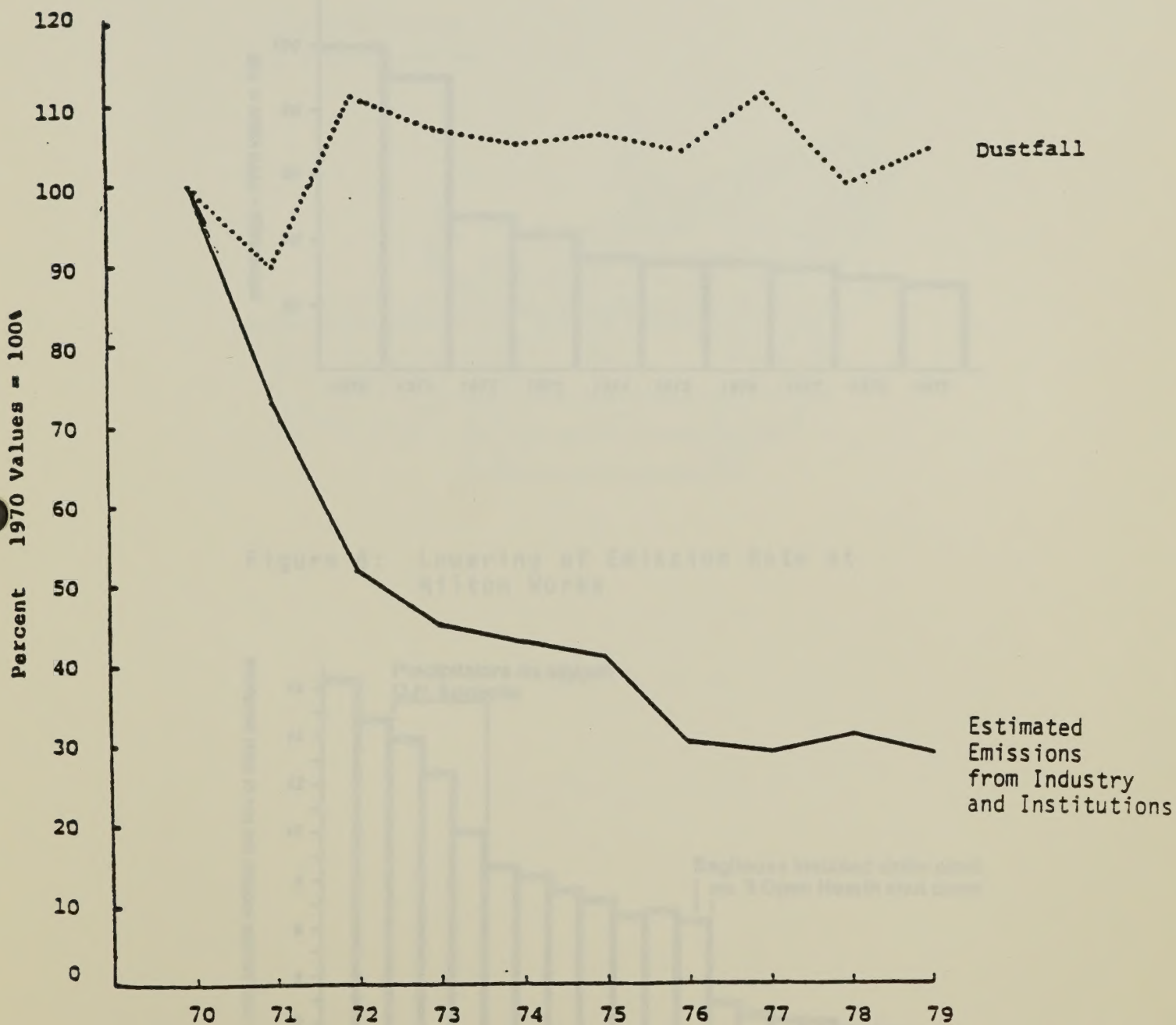


Source: Ontario Ministry of Environment

Figure 2: Estimated Population Trends of Estimated Total Fishery
 Y-axis: 1970-1974



Figure 4: Dustfall Trends vs Estimated Total Emissions
Hamilton 1970-1979



Source: Ontario Ministry of Environment

Figure 4: Seasonal Trends in Estimated Total Emissions
 Hamilton 1970-1979

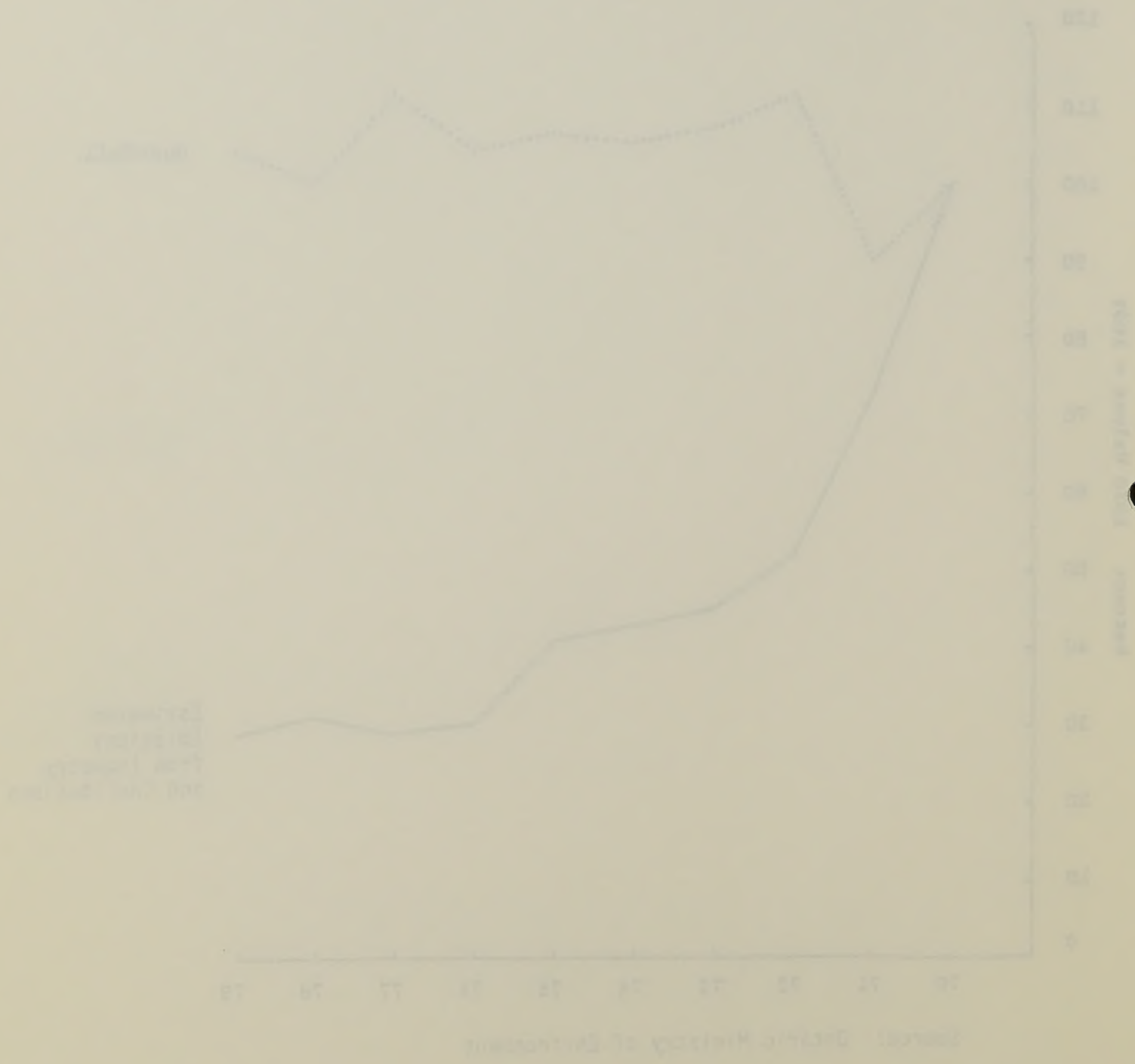


Figure 5: Reduction of Hilton Works
Particulate Emissions



Figure 6: Lowering of Emission Rate at
Hilton Works

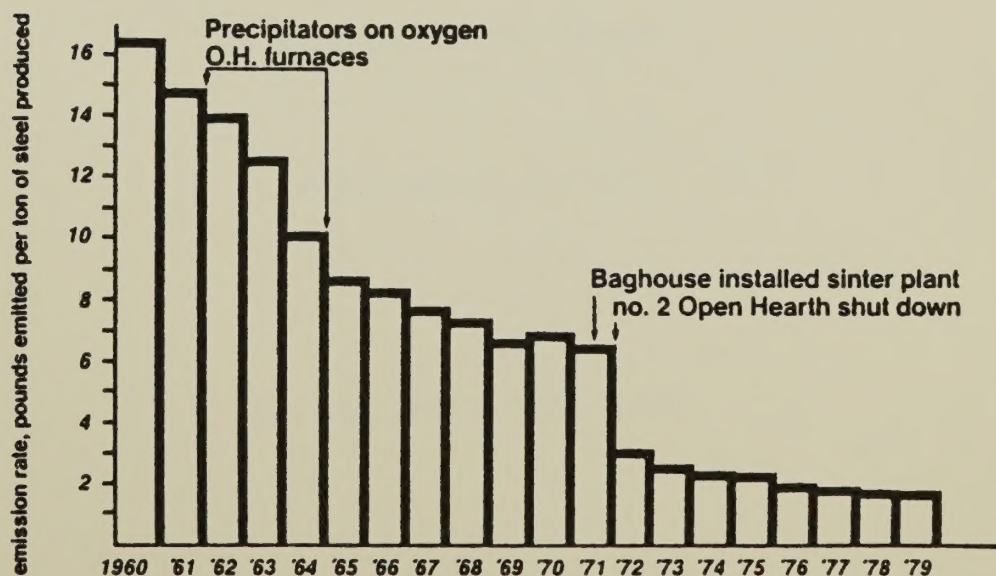


Figure 2: Distribution of Birth Years
 1950-1959

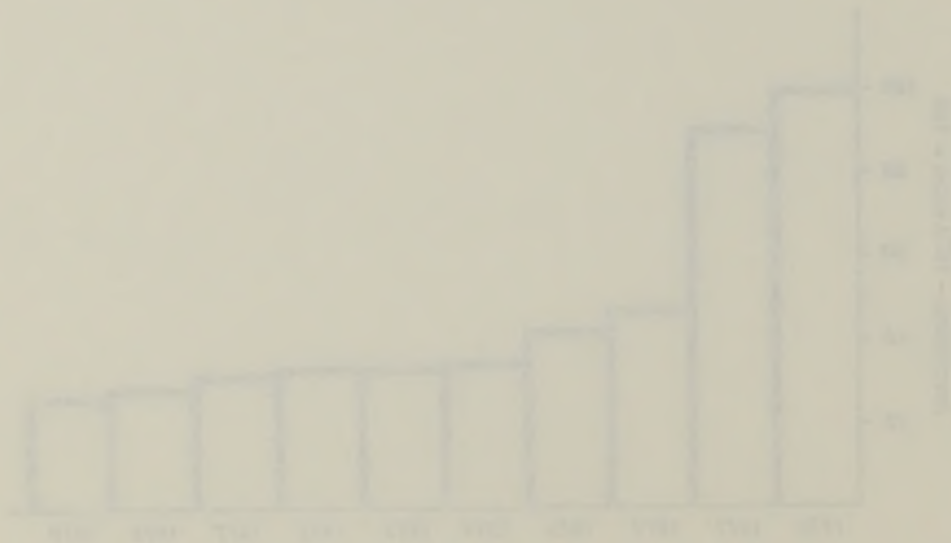


Figure 3: Location of Birth Years
 1950-1959

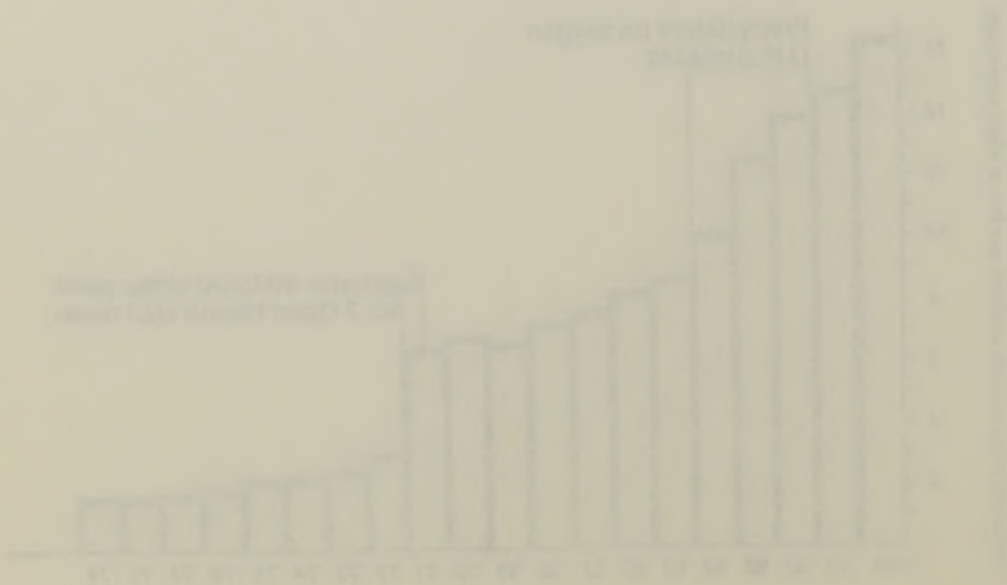


Figure 7: Types of Emissions from
Coke Oven Batteries

- ① Pushing emissions
- ② Charging emissions

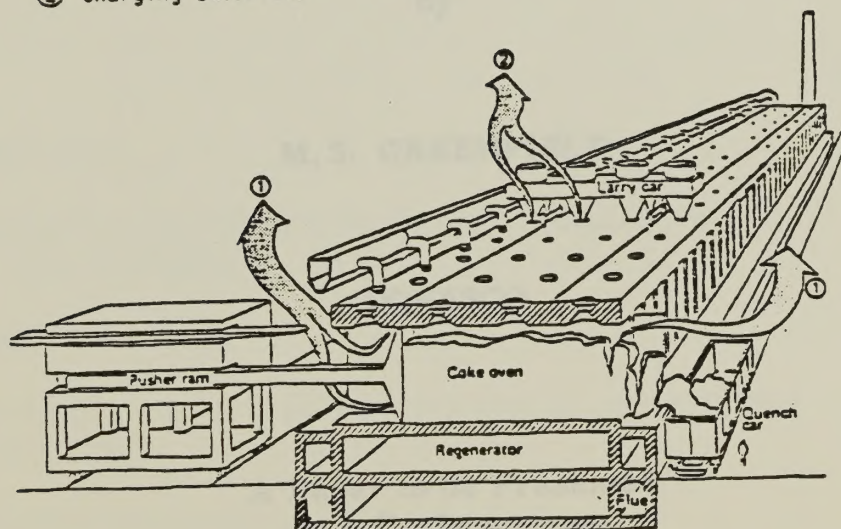


Figure 1: Types of Buildings
East Asia

1. Temple
2. Palace



AIR POLLUTION CONTROL AT DOFASCO

by

M. S. GREENFIELD

DOFASCO

A Paper to be Presented
at a Conference on

"A Quarter Century of Environmental Progress
in the Hamilton Area and
a Blueprint for the Future"

MOHAWK COLLEGE

November 14th 15th, 1980

THE POLITICAL CONSTITUTION OF THE UNITED STATES

BY

W. E. GLASSBORO

NEW YORK

A. L. BAKER, JR.
100 N. 3RD ST., PHILADELPHIA, PA.

5 QUARTER CENTURY OF THE CONSTITUTIONAL HISTORY

OF THE UNITED STATES AND

A DISCUSSION OF THE THEORY

OF THE CONSTITUTION

REVISED EDITION, 1901

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3	RESULTS
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EMISSIONS

FIGURE 10: A 3D PLOT OF THE SURFACE $z = 1 - x^2 - y^2$

FIGURE 10

FIGURE 11: A 3D PLOT OF THE SURFACE $z = 1 - x^2 - y^2$ WITH THE TANGENT PLANE AT THE POINT $(1, 1, -1)$

FIGURE 11

FIGURE 12: A 3D PLOT OF THE SURFACE $z = 1 - x^2 - y^2$ WITH THE TANGENT PLANE AT THE POINT $(1, 1, -1)$ AND THE NORMAL LINE

FIGURE 12

AIR POLLUTION CONTROL AT DOFASCO

INTRODUCTION

Dofasco is a fully integrated steel producer manufacturing a variety of flat rolled steel products and castings from our nearly 700-acre plant located in Hamilton. The Company is Canada's second largest steelmaker and provides more than 20% of the country's total domestic steel production.

In 1979 production exceeded 4.0 million ingot tons for the first time while consolidated sales was a record \$1.4 billion. Dofasco employs more than 11,000 people in steelmaking operations and nearly 98% of Dofasco shares are held in Canada.

Since the late 1960's when the company's first major pollution control programmes were established, significant progress has been achieved. While product has increased by 75% and employment by more than 4,000, total emissions, both air and water, have been reduced by more than 2/3. Our rate of particulate emissions over this period has decreased by approximately 80% -- from 6 lb. to 1 lb. per ton of steel produced.

INTRODUCTION

Canada is a fully developed steel producing manufacturing country in that rolled steel products and castings form an integral part of the economy. The Company is Canada's largest producer and provides more than 10% of the country's total domestic steel production.

In 1975 production exceeded 2.5 million tons for the first time while consolidated sales were a record \$1.2 billion. Canada's steel industry has 11,000 people in manufacturing operations and nearly 85% of its products are sold in Canada.

Since the late 1960's when the company's first major pollution control programme was initiated, significant progress has been achieved. While production has increased by 75% and employment by more than 4,000, total emissions, both air and water, have been reduced by more than 50%. Our rate of particulate emissions per ton of steel produced has decreased by approximately 50% -- from 5 lb. to 2.5 lb. per ton of steel produced.

Reducing air emissions to current levels has been expensive with capital expenditures for air pollution alone totalling \$60 million since 1970.

Operating costs, including amortization, have amounted to \$13 million per year. Dofasco's total capital expenditures on environmental control from 1970-1979 are approximately \$110 million.

This paper will outline:

- a) Major Particulate Control Installations -- Past and Future
- b) SO₂ Emissions
- c) A Comparison of NO_x Emissions from Various Steel Industry Fuels.

...the amount of investment in current assets has been approximately equal
...the amount of investment in fixed assets has been approximately equal
...the amount of investment in working capital has been approximately equal
...the amount of investment in other assets has been approximately equal
...the amount of investment in total assets has been approximately equal

This paper will outline:

- a) Major Particulars of the Investment -- Total and
Where
- b) Major Particulars of the Investment -- Total and
Where
- c) Major Particulars of the Investment -- Total and
Where

A) MAJOR PARTICULATE CONTROL INSTALLATIONS
PAST AND FUTURE

Road, Yard and Storage Pile Emissions

Emissions from road, yard and storage piles are dependent on wind velocity and traffic density. High winds blowing across open areas or storage piles containing fine materials can carry away considerable dust. Vehicular traffic driving down dusty roads also kicks up considerable dust.

Raw Material Storage and Handling

Figure 1 outlines the basic flow of raw materials into the processes.

The iron ore is in the form of strong stable pellets. Similarly, the limestone and dolomite are relatively non-dusting. On the other hand, coal is fine and will blow away in high winds unless it is kept wet or an oil coating is applied.

Eleven large water spray towers have been installed at a cost of \$1 million to wet down the piles as required (Fig. 2).

Three tank trucks and 2 water wagons are also used to spray water and oil on the coal as well as open areas. The piles are rolled and contoured to eliminate sharp edges which can cause turbulence and subsequent dusting.

ANALYSIS OF PARTICULATE MATTER IN AERIAL
POST BOXES

Field Work and Sample Collection

Locations from which field and storage boxes are deposited are along
valleys and localities. These sites should be chosen where there are
average flow conditions. The analysis can only be conducted when
there are traffic flow and there should also be a record of the flow.

Field Work and Sample Collection

Figure 1 illustrates the basic flow of the material from the box.

The main one is in the form of a single plastic bottle. The material
and delivery are relatively unimportant. The other hand, it is the
and will have only a slight effect on the flow. The flow is
applied.

Eleven large water spray tanks have been installed at a cost of \$1 million
to wet down the dust in the air.

Three tank trucks and 2 water sprays are also used to spray water and oil
on the road as well as over areas. The pipes are rubber and connected to
eliminate sharp edges which can cause discomfort and subsequent swelling.

Materials are taken from storage piles and are fed into the processing units by conveyor belts or transfer cars. Locations where material is dropped from one handling system to another are shrouded as shown in Fig. 3.

The dust contained inside the shroud is exhausted to a gas cleaning device. At #1 Oxygen Steelmaking Shop, there are 30 such collection points alone for the lime and limestone conveying system.

Roadways and Open Areas

Dofasco uses 3 street sweepers and 2 flushers to keep the 29 kilometers of internal plant roads clean. Operating costs for this equipment is in excess of \$900,000 per year. This equipment is operated on a regular basis and around the clock when conditions warrant it. One truck is used to apply oil to non-paved roads and parking lots. City streets in close proximity to our plant and used extensively for materials handling are also maintained by our cleaning equipment.

Future reductions in dusting will be attained by paving more roads and parking lots as well and increasing the cleaning frequency. As well, street cleaning equipment currently employed does not adequately handle our needs during the more severe winter conditions. More efficient winter time street sweepers are presently being sought out and evaluated.

Greenbelting

Today, nearly 15 acres of the plant have been grassed and landscaped.

This represents about 2% of our total plant area. Future plans call for more areas to be grassed and planted.

Summary

Over the last 10 years Dofasco has achieved an estimated 75% reduction in raw material, open area and roadway emissions. By 1982 we expect a 90% reduction will have been attained (Fig. 4).

Process Emission Control

Process emissions are discharged from stacks and building ventilators, generally above ground level. The process emissions are generally small in size and are carried quite a distance from the plant before settling out as opposed to road, yard and storage pile dust which is generally much coarser and settles out either inside or in close proximity to the plant.

Coke Ovens

One of the greatest technical challenges being met is the control of emissions from coke ovens.

Coking

An oven is a long, narrow rectangular chamber. Doors at each end of the oven are removed to allow the coke to be "pushed" out. There are three

Observations

Today, nearly 15 acres of the plant have been cleared and replanted. This represents about 25% of the total plant area. Future plans call for more work in the cleared and replanted.

Summary

Over the past 10 years, the plant has achieved an excellent 75% reduction in the amount of land cleared and replanted. The amount of land cleared and replanted will have been reduced 75%.

Recommendations

Further work should be directed from cleared and replanted areas. The present situation is that the plant has achieved an excellent 75% reduction in the amount of land cleared and replanted. The amount of land cleared and replanted will have been reduced 75%.

Conclusion

One of the greatest technical challenges facing the plant is the amount of land cleared and replanted. The amount of land cleared and replanted will have been reduced 75%.

References

An excellent book, "The Plant" by the author, is available. The amount of land cleared and replanted will have been reduced 75%.

holes on top for charging and one for the evolution of the gas produced.

Between each pair of ovens is a row of heating flues in which coke oven gas or preheated blast furnace gas is burned with preheated air to provide the heat of carbonization.

After an oven has been pushed, the doors are put on and the charging hole covers are removed. A coal charging car is loaded with enough coal to fill one oven -- 16.0 tons, and the coal is charged into the oven.

Coke Oven Charging

Coke oven emissions have received considerable attention due to the hazardous organic components that can be emitted if no controls are in place. Prior to 1970 most coal charging cars were obscured by smoke emissions during the entire charge. Since then significant progress in reducing nearly all emissions has been achieved. The first technology used for control of charging emissions at Dofasco was a larry car scrubber installed in 1971 at No. 2 Coke Plant (Fig. 5).

Emissions created as the coal contacts the hot oven walls are collected as they exit the charging hole. The car must pick up clean water and dump dirty water after every charge. This technology is approximately 80% effective at removing particulate and organic emissions. While 80%

efficiency was considered good the introduction of new technology (staged charges) provides even further capturing capability. This process has been installed at Nos. 1 and 3 Coke Plants. With staged charging, emissions are not allowed to escape the oven into the atmosphere. Standpipes evacuate the gases at a sufficient rate to keep the entire oven under negative suction. The coal charging rate is slowed down so that production of gases during the charge does not exceed the capacity of the standpipe to take the emissions away. The staged charging process captures more than 95 percent of emissions.

At #1 and #2 Coke Plants, there is a single collecting main. The #1 charging car is being equipped with a smoke pipe and tighter fitting jumper pipe to prevent the gases from escaping the oven (Fig. 6).

Dofasco's newest battery is equipped with a double collector main which includes a standpipe at either end of the oven (Fig. 7).

Except for the occasional wisp, smoke-free conditions are attained over the entire charge due to tight-fitting charging sleeves and suction from the standpipes.

efficiency was considered good for the purpose of new technology (Fig. 1).
 One of the main reasons for this is the fact that the new technology has been
 installed at 100% and 50% respectively. With regard to the new technology, the
 new system is expected to reduce the cost of the new technology. The new system
 has been at a very low rate to keep the entire new system under control.
 The new technology rate is shown in the new production of new technology.
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At 10 and 50% respectively, there is a slight reduction in the new technology rate.
 The new technology rate is shown in the new production of new technology.
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The new technology rate is shown in the new production of new technology.
 The new technology rate is shown in the new production of new technology.

Coking Cycle

Once the coal is in the ovens, the lids and caps are inserted in place, and the standpipe suction system reduced resulting in positive pressures inside the oven. The gases produced are piped to the By-products Plant for cleaning and subsequent use as a fuel. The pressure inside the oven during the coking cycle is positive, resulting in emissions at any gap in the brickwork, door seals (Fig. 8), lids or standpipe caps.

With 246 individual coke ovens, Dofasco must maintain over a kilometer of sealing surfaces. A considerable number of manhours are spent patching brickwork, repairing and cleaning door seals and jambs, sealing standpipe caps and charging lids to minimize leaks. Formerly, it was common in the coke industry to have over 33% of the doors leaking at any one time. A proposed U. S. Environmental Protection Act standard would limit the number of leaking doors to 10%.

Currently, Dofasco is able to keep the number of doors leaking to below 10%.

Pushing Emissions

After a 16-hour period, the coal in the oven has been converted to coke and is pushed out. Since the coal has been heated uniformly to 1100°C, most of the hazardous organics have been evolved and only coke remains. The batteries at Dofasco are well maintained and operated which minimizes pushing emission pollution. The coke is caught in a coke car, mounted on

railroad tracks. The emissions from pushing are collected and cleaned at two of Dofasco's three coke complexes. At #1 Coke Plant, the coke side of the battery is enclosed by a building or shed constructed along the length of the battery. The fumes captured in the shed are cleaned by a wet electrostatic precipitator (Fig. 9).

At #3 Coke Plant, a travelling hood has been installed (Fig. 10), which collects the emissions from the coke-receiving car during the push and during the travel to the quench tower.

The travelling hood is located close to the source of emissions and requires much less air to be cleaned as compared to the shed.

TABLE 1
COMPARISON OF COKE PUSHING SYSTEM
AIR CLEANING REQUIREMENTS

	Coke Side Shed #1 Coke Plant - 1976 -	Travelling Hood #3 Coke Plant - 1978 -
Gas Flow to Cleaning Device	6800 m ³ /tonne	2000 m ³ /tonne
Particulate Emission Rate	30 g/tonne	3 g/tonne

The shed technology requires higher energy costs for gas cleaning. On the other hand, because of its sophisticated mechanical operation, the travelling hood system requires more maintenance. One of the two systems will be installed at our #2 Coke Plant after further evaluation.

Quenching

The hot coke is transported to the quench tower, where it is cooled with water. The large steam plume produced passes through baffles which removes approximately 75% of the particulate (Fig. 11).

Blast Furnace Casting

The waste gas from the smelting of iron ore in a blast furnace exits the top of the furnace, carrying considerable particulate. After a thorough cleaning, the gas is used as a fuel -- thus reducing our need for purchased fuel. About 50% of Dofasco's energy demand is met through the use of by-product gases.

Emissions are also produced when the iron is tapped (drained) from the furnace. Emissions amount to only .03% of the metal being cast. However, this emission level still exceeds current government criteria and further work is being undertaken to reduce emissions. To capture the particulate produced as the iron travels along the 30 or 50 feet of runner, requires large amounts of air to be evacuated from the cast house.

For example, the waste "top gas" from #1 Blast Furnace amounts to about 210,000 m³/h. However, 510,000 m³/h are required to clean up casting emissions (Fig. 12).

Nos. 1 and 3 Blast Furnaces are currently equipped with total-building evacuation systems. A local collection system featuring collection at the tap hole and torpedo car filling station, along with covers over the runners (Fig. 13) will be installed at #2 and #4 Blast Furnaces.

At a later date, #3 Blast Furnace will be converted to local collection. Under present operations, approximately 90 percent of potential Blast Furnace emissions are captured.

Steelmaking

Dofasco uses the basic oxygen furnace technique for producing steel. Scrap is charged into the vessel first, followed by molten iron. The liquid iron causes the impurities in the scrap to burn, producing considerable flame and fumes. Both of Dofasco's steelmaking shops are equipped with systems for collecting the emissions from charging. At #1 Oxygen Steelmaking Shop, a hood is located in the truss work of the building high above the furnace (Fig. 15). There was no room in the proximity of the mouth of the furnace for a local hood.

No. 2 Oxygen Steelmaking Shop, started up in 1978, was designed to allow for the installation of a local hood close to the furnace mouth for collection of charging emissions.

Once the materials are charged into the furnace, oxygen is blown through a lance located above the bath of molten iron. The oxygen reacts with carbon in the iron to form carbon monoxide.

At the older #1 Shop, the carbon monoxide evolved from the oxygen blowing is allowed to burn as it exits the furnace. The gases are collected by a hood above the furnace, cooled and cleaned.

At #2 Shop, a skirt is lowered between the hood and the furnace, which prevents the carbon monoxide from burning (Fig. 14). The volumes of gas produced during the oxygen blowing operation are, therefore, much smaller than at #1 Shop.

TABLE 2

	#1 Oxygen Steelmaking - 1954 -		#2 Oxygen Steelmaking - 1978 -	
	Charging	Blowing	Charging	Blowing
Gas Volume m ³ /tonne	85	1556	57	248
Particulate Emissions after Scrubber g/tonne	0.16	3.0	0.04	0.16

The 2000-2001 season was started on 15th, and finished on 15th. The installation of a local road close to the forest, which the collection of changing conditions.

From the materials and changes in the forest, which is shown through a table located above the table of water level. The water level with water is the level to level water.

At the other 2000, the water level was shown from the water level. It showed to level as it with the forest. The water was collected by a table above the forest, which was shown.

At 2000, a water level was shown between the forest and the forest, which was shown the water level from the forest. The water level of gas collected during the water level, which was shown, which was shown, which was shown at 2000.

TABLE 2

Year Volume of Water	Water Level	Water Level	Water Level	Water Level	Water Level
2000	0.18	0.18	0.18	0.18	0.18
2001	0.18	0.18	0.18	0.18	0.18
2002	0.18	0.18	0.18	0.18	0.18
2003	0.18	0.18	0.18	0.18	0.18
2004	0.18	0.18	0.18	0.18	0.18
2005	0.18	0.18	0.18	0.18	0.18
2006	0.18	0.18	0.18	0.18	0.18
2007	0.18	0.18	0.18	0.18	0.18
2008	0.18	0.18	0.18	0.18	0.18
2009	0.18	0.18	0.18	0.18	0.18
2010	0.18	0.18	0.18	0.18	0.18
2011	0.18	0.18	0.18	0.18	0.18
2012	0.18	0.18	0.18	0.18	0.18
2013	0.18	0.18	0.18	0.18	0.18
2014	0.18	0.18	0.18	0.18	0.18
2015	0.18	0.18	0.18	0.18	0.18
2016	0.18	0.18	0.18	0.18	0.18
2017	0.18	0.18	0.18	0.18	0.18
2018	0.18	0.18	0.18	0.18	0.18
2019	0.18	0.18	0.18	0.18	0.18
2020	0.18	0.18	0.18	0.18	0.18
2021	0.18	0.18	0.18	0.18	0.18
2022	0.18	0.18	0.18	0.18	0.18
2023	0.18	0.18	0.18	0.18	0.18
2024	0.18	0.18	0.18	0.18	0.18
2025	0.18	0.18	0.18	0.18	0.18
2026	0.18	0.18	0.18	0.18	0.18
2027	0.18	0.18	0.18	0.18	0.18
2028	0.18	0.18	0.18	0.18	0.18
2029	0.18	0.18	0.18	0.18	0.18
2030	0.18	0.18	0.18	0.18	0.18

Table 2 shows the much lower emissions attained at #2 Shop. This Shop was designed with pollution control in mind, whereas #1 Shop was commissioned when strict pollution control standards did not exist.

While about 99% of blowing emissions from #1 Shop stacks are captured they still exceed Environment Ontario smoke density regulations. Modifications to the gas cleaning system are being made to improve the scrubbing efficiency from 99% to 99.5% (Fig. 16) at an estimated cost of \$1 million. These changes should reduce the smoke density or opacity to meet Environment Ontario requirements.

Table 1 shows the results of the regression analysis of the data. The results show that the regression model is a good fit for the data. The adjusted R-squared value is 0.85, which indicates that 85% of the variation in the dependent variable is explained by the independent variables. The F-statistic is 12.34, which is significant at the 0.01 level. The p-values for the independent variables are all less than 0.05, indicating that they are all significant predictors of the dependent variable.

While about 90% of the data points are within the predicted range, there are still some outliers. These outliers are likely due to measurement error or other factors. The regression model is still a good fit for the data, but the outliers do suggest that there may be some unexplained variation in the data. The adjusted R-squared value is 0.85, which is a good fit for the data. The F-statistic is 12.34, which is significant at the 0.01 level. The p-values for the independent variables are all less than 0.05, indicating that they are all significant predictors of the dependent variable.

B)

SO₂ EMISSIONS

The following table illustrates the source of fuel used for the various combustion processes at Dofasco.

TABLE 3

FUEL	% OF PLANT ENERGY	SULPHUR CONTENT
Blast Furnace Gas	48	Negligible
Coke Oven Gas	40	Negligible, due to desulphurization in Stretford Plant
Natural Gas	7	Negligible
#6 Fuel Oil	5	1.3% Sulphur content in fuel

Blast furnace gas is sulphur-free. Coke oven gas contains about 8 grams per cubic meter of hydrogen sulphide which if burned is converted to sulphur dioxide. Dofasco operates 3 separate Stretford plants with sufficient capacity to desulphurize its coke oven gas (Fig. 17).

Therefore, only 5% of the energy used for combustion sources at Dofasco contributes SO₂ to Hamilton's atmosphere. Over 98% of Dofasco's potential

SO₂ emissions are captured and treated through control processes. This performance meets the Ministry of Environment requirements.

C) A COMPARISON OF NO_x EMISSIONS
FROM DIFFERENT FUEL SOURCES

Oxides of nitrogen, as well as sulphur oxides, cause acid rain.

Oxides of nitrogen are formed in high temperature combustion reactions when the nitrogen in the air or fuel reacts with oxygen in the air to form NO_x. High temperatures, high excess oxygen levels and time at temperature favor higher NO_x levels.

Blast furnace gas and coke oven gas burn at lower flame temperatures than other fuels, reducing NO_x formation.

NO_x emissions are reported and listed through annual processes. This performance meets the Ministry of Environment requirements.

A COMPARISON OF NO_x EMISSIONS FROM DIFFERENT TYPES OF WORK

Order of reference, as well as various other, some with rate.

Order of reference are listed in high temperature conditions. When the nitrogen in the air is not treated with oxygen in the air in form of NO_x, this concentration, with certain nitrogen levels and then at

temperature level higher than 1000°C.

These nitrogen gas and some other gas are at lower than temperatures than when fuels reacting NO_x formation.

TABLE 4

FUEL BURNED	NO _x Emissions for Various Fuels grams/ million joules
#6 Fuel Oil	0.17 (Actual Measurement)
Natural Gas	0.13 (Literature)
Coke Oven Gas	0.03 (Actual Measurement)
Blast Furnace Gas	0.0043 (Actual Measurement)

Dofasco NO_x emissions are much lower than would be produced if natural gas and #6 fuel oil were the only fuels used.

TABLE 1

STATION	WATER SAMPLED
1	1000 ft. deep
2	2000 ft. deep
3	3000 ft. deep
4	4000 ft. deep
5	5000 ft. deep
6	6000 ft. deep
7	7000 ft. deep
8	8000 ft. deep
9	9000 ft. deep
10	10000 ft. deep

Notes: 1. All samples were taken from the same station. 2. All samples were taken from the same station. 3. All samples were taken from the same station. 4. All samples were taken from the same station. 5. All samples were taken from the same station. 6. All samples were taken from the same station. 7. All samples were taken from the same station. 8. All samples were taken from the same station. 9. All samples were taken from the same station. 10. All samples were taken from the same station.

CONCLUDING REMARKS

Since 1970 Dofasco has devoted considerable effort toward the reduction of all emissions from our plant. The results have been excellent. When we first began our comprehensive programme much of the necessary technology either had not been developed or was still in its embryonic stages. Today some 10 years later, we discharge much less, even though production has nearly doubled. Our particulate emissions have been reduced on average by 76% (Fig. 18) and in many operations, such as our Melt Shop areas, better than 99% of particulate emissions are now captured.

Most of the work required to bring our existing plant into compliance with Ministry of Environment regulations has now been completed. This past summer a new Ministerial Control Order was finalized which, when completed over the next few years, will further reduce air particulate emissions and bring all of our operations into compliance with Ministry standards. The projected capital cost of completing the air pollution portion of the work is approximately \$22 million and involves three control installations. A further \$18 million will be devoted to water pollution through the same Control Order.

At Dofasco, pollution control will continue to be a major consideration for any new installation. Currently, the company is in the midst of a major

CONCLUDING REMARKS

Since 1970 Britain has devoted considerable effort towards the reduction of all emissions from our plants. The results have been excellent. When we first began our comprehensive programme much of the necessary technology either had not been developed or was still in its infancy stages. Today some 12 years later, we have made much headway, even though pollution has nearly doubled. Our particulate emissions have been reduced by 80% in 1975, 1976, 1977 and in many operations, such as our steel shop, even better than 90% of particulate emissions are now captured.

None of the work required in being our existing plant into compliance with Ministry of Environment regulations has yet been completed. This year we expect a new Environmental Control Order will be issued which, when completed over the next few years, will further reduce our particulate emissions and bring all of our operations into compliance with Ministry standards. The projected capital cost of completing the air pollution portion of the work is approximately £21 million and involves three control installations. A further £18 million will be needed to provide pollution through the same Control Order.

At Ebbw Vale, pollution control will continue to be a major consideration for our new installation. Currently, the company is in the midst of a major

POTENTIAL AIR POLLUTANT
EMISSIONS FROM STEEL

expansion programme which will increase production from the 4.0 to 4.5 million ton level by 1985 and to the 6.0 million ton level during the 1990's. A major part of our expansion programme is the construction of a \$450 million Hot Strip Mill scheduled for completion in 1983. Pollution control equipment for this mill will approach \$40 million, bringing our total pollution abatement capital expenditures over the next few years to \$80 million.

Although environmental control costs are large and increasing, Dofasco accepts such costs as an essential part of doing business.

COAL PILE DUST SUPPRESSION
WATER SPRAY TOWER



expansion program which will increase production from 4 to 4.5 million tons by 1962 and to 5.0 million tons by 1965.

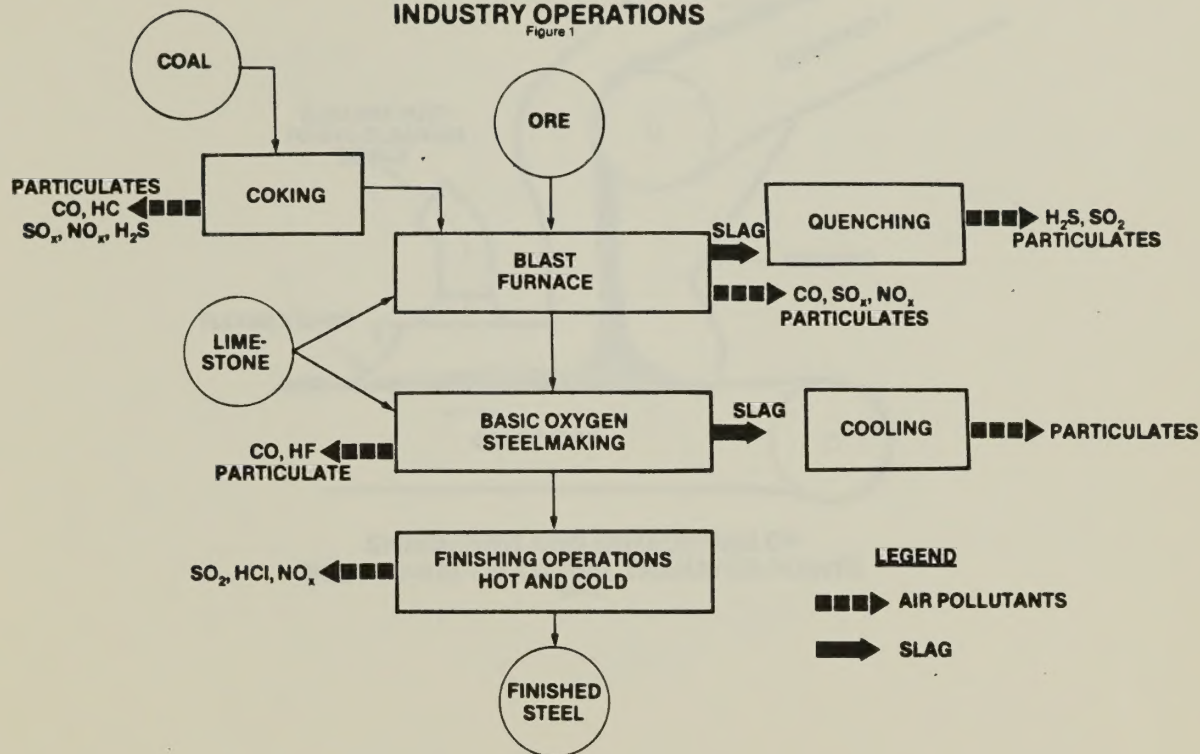
A major part of our expansion program is the construction of a new 200,000 ton ship mill scheduled for completion in 1961. This mill will

expand our 1958 mill and increase production to 5.0 million tons. Capital expenditures for the next five years are \$100 million.

Through government, labor and management efforts, we hope to make our company one of the most successful in the world.

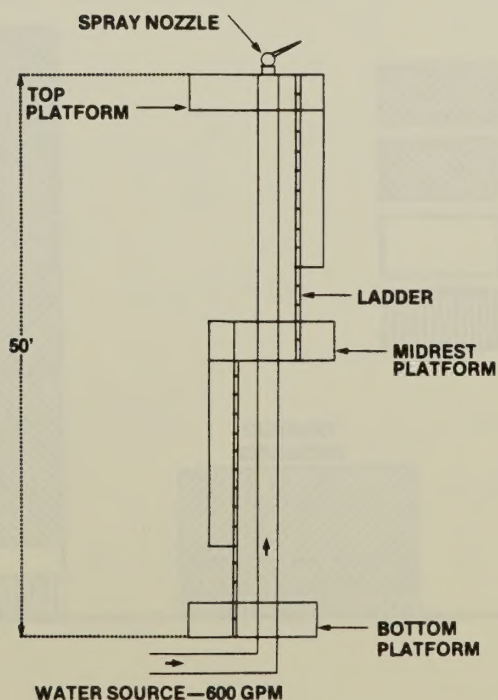
POTENTIAL AIR POLLUTANT EMISSIONS FROM STEEL INDUSTRY OPERATIONS

Figure 1



COAL PILE DUST SUPPRESSION WATER SPRAY TOWER

Figure 2

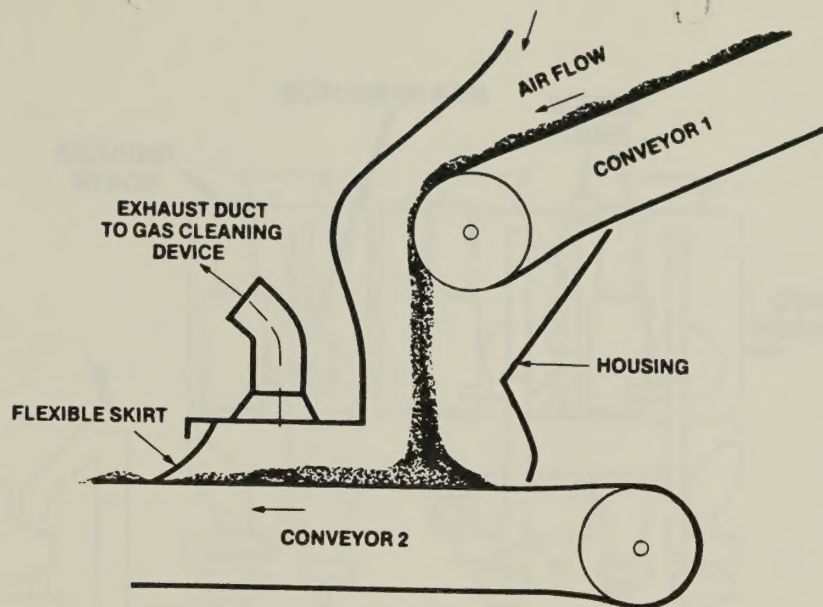


SYSTEMS ANALYSIS



SYSTEMS ANALYSIS





SHROUDING AND EXHAUSTING OF
BELT-TO-BELT MATERIAL TRANSFER POINTS

Figure 3

REDUCTION OF DOFASCO YARD & ROAD DUST EMISSIONS

Figure 4

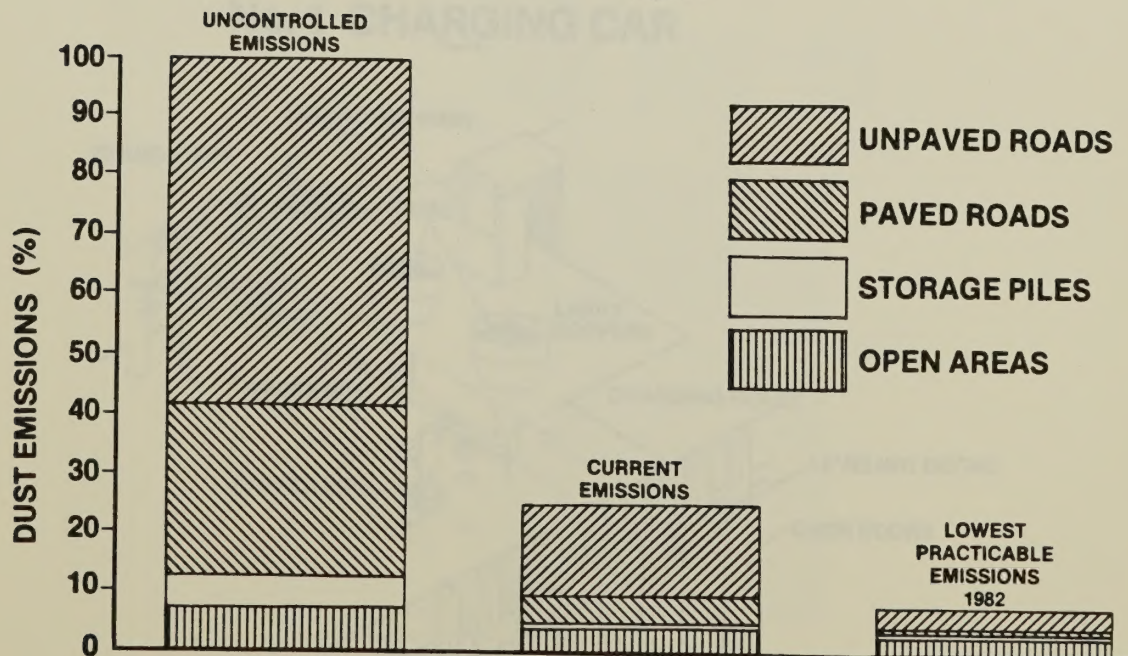




FIGURE 1. Schematic diagram of the study area showing the location of the roads and the building footprint.

REDUCTION OF DUST EMISSIONS YARD & ROAD DUST EMISSIONS



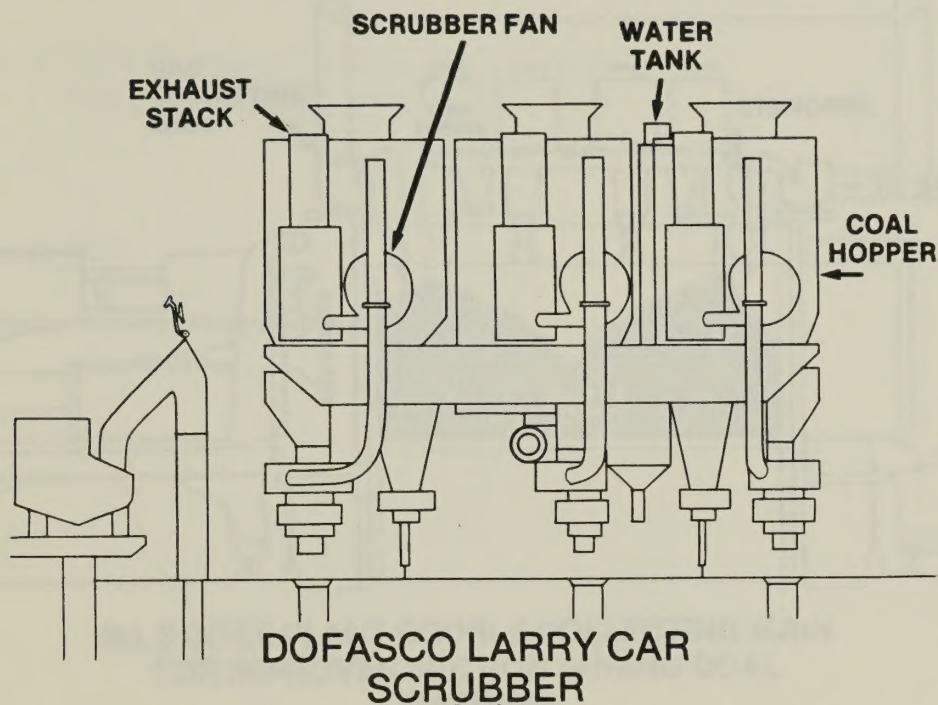
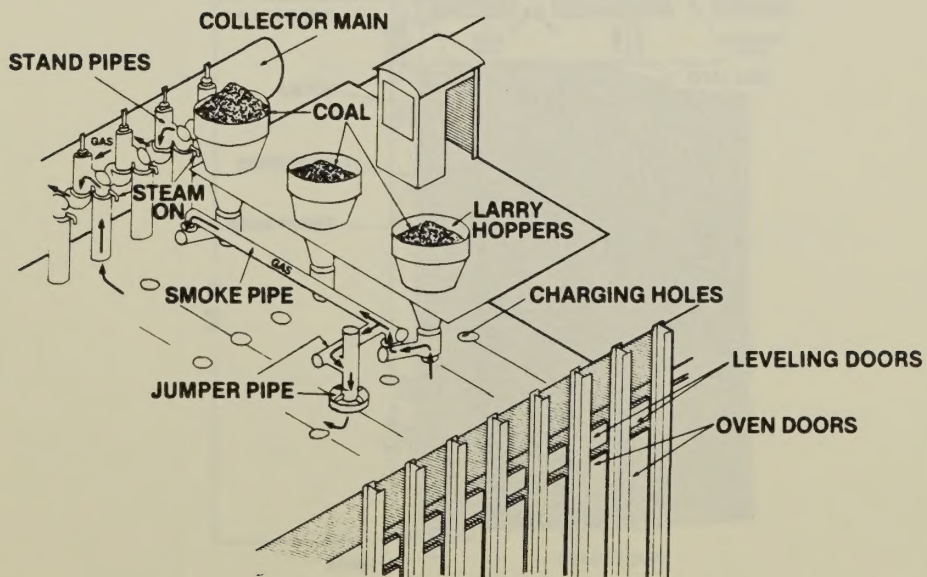


Figure 5

No. 1 CHARGING CAR

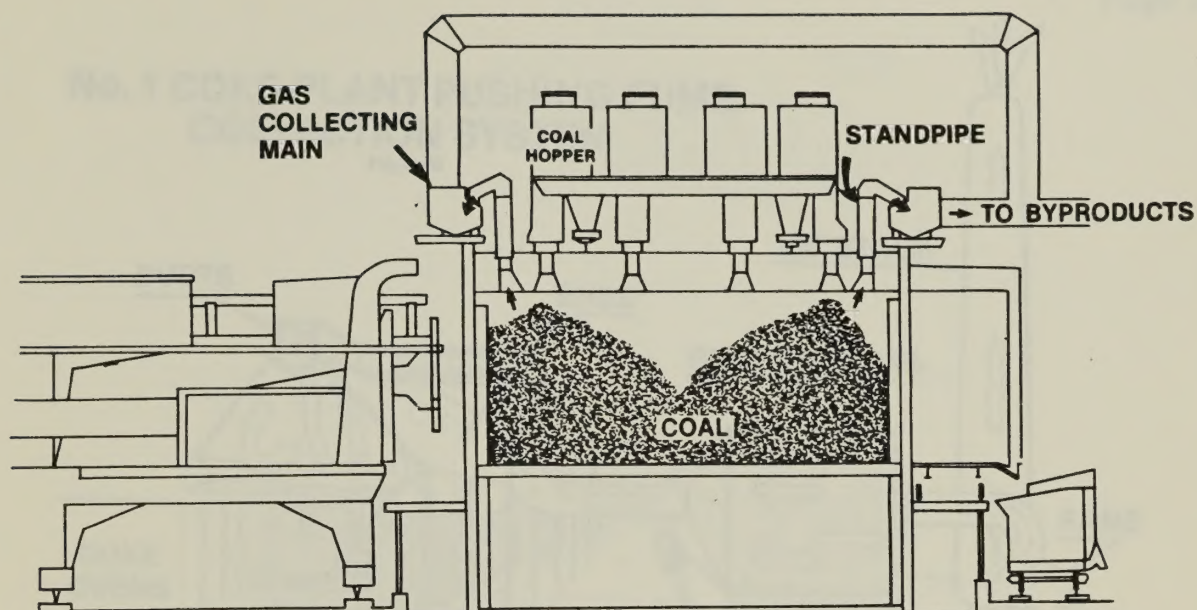
Figure 6





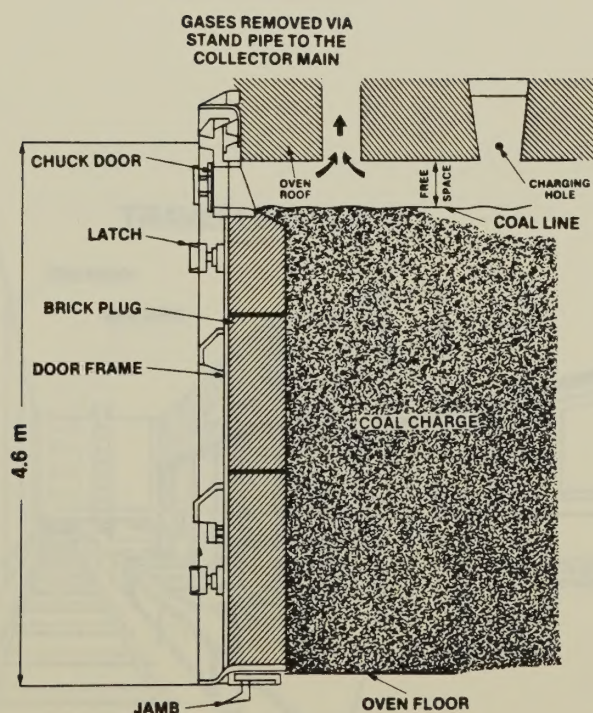
NO. 1 CHARGING CAR





**No. 3 COKE PLANT DOUBLE COLLECTING MAIN
FOR IMPROVED SUCTION DURING COAL
CHARGING**

Figure 7



**VERTICAL CROSS SECTION OF KOPPERS
COKE OVEN DOOR**

Figure 8



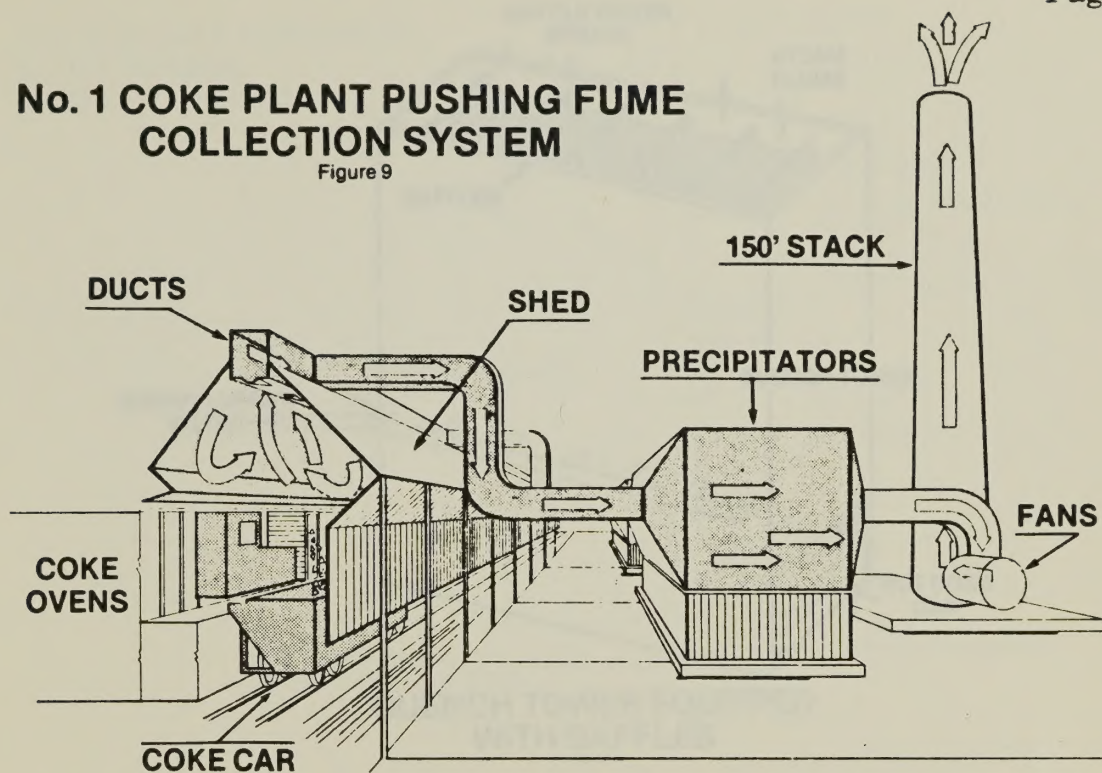
PLAN OF LIVING ROOM AND DINING ROOM
SHOWING FURNITURE AND FIXTURES



PLAN OF KITCHEN AND BATHROOM
SHOWING FURNITURE AND FIXTURES

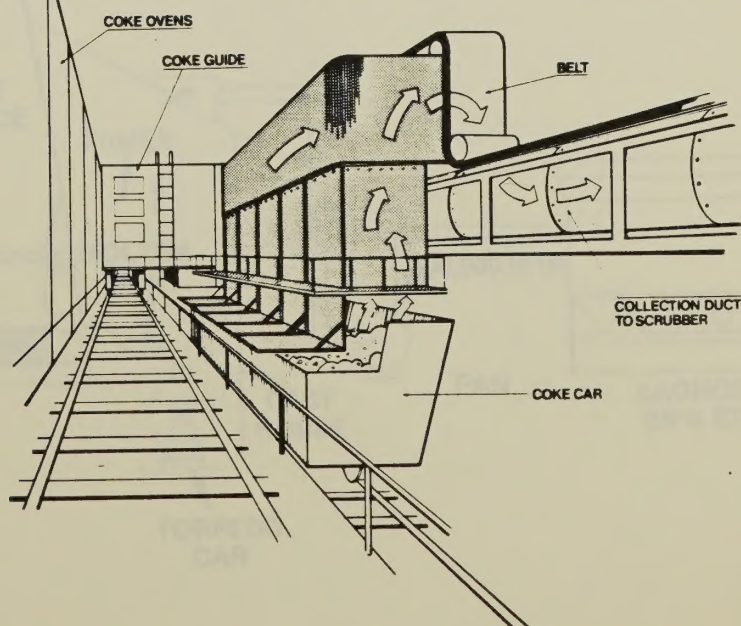
No. 1 COKE PLANT PUSHING FUME COLLECTION SYSTEM

Figure 9



TRAVELLING HOOD

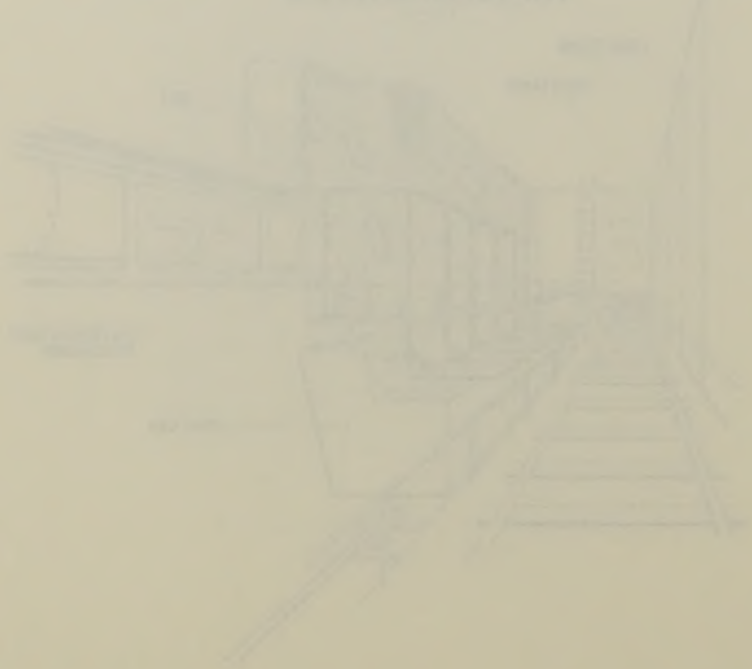
Figure 10

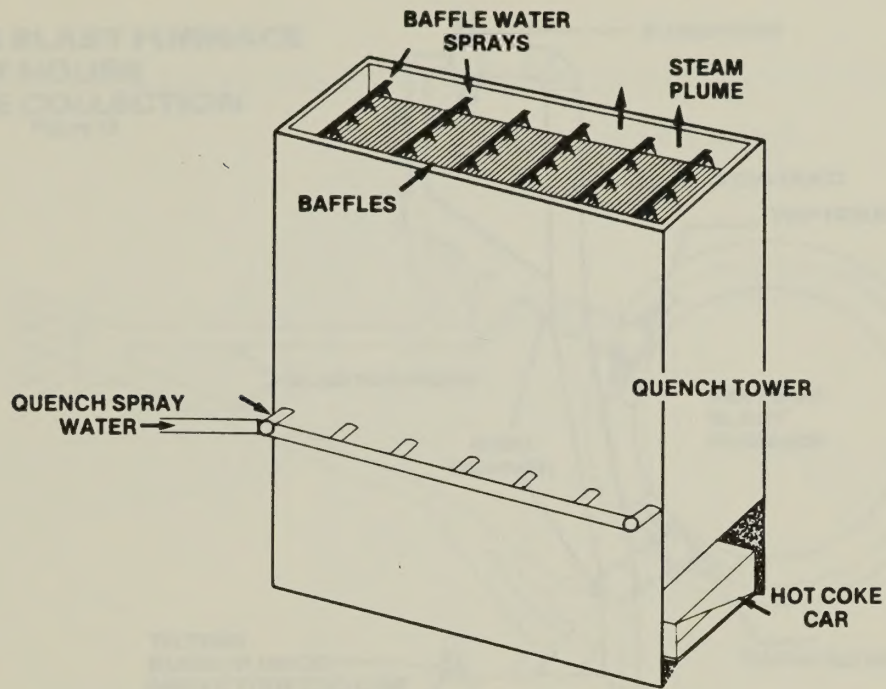


NO. 1 CORE FLANT PUSING FOME COLL ECTION SYSTEM



THE FLANT SECTION



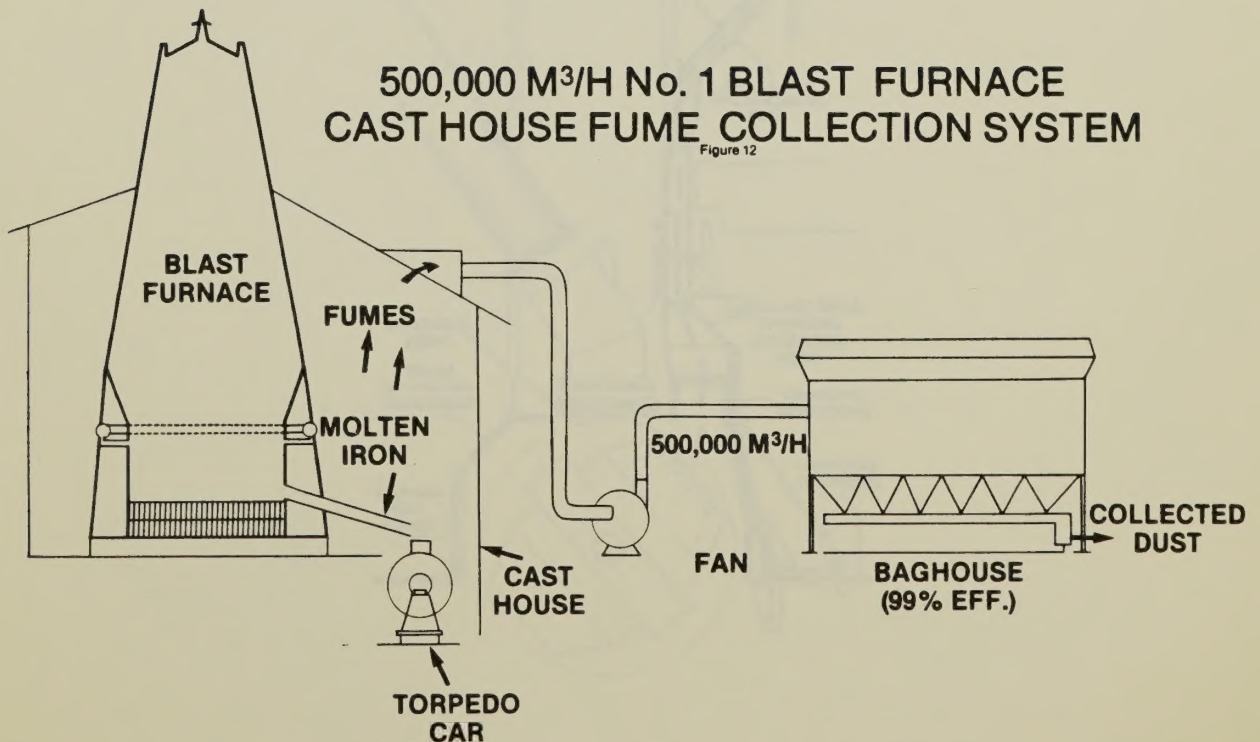


QUENCH TOWER EQUIPPED WITH BAFFLES

Figure 11

500,000 M³/H No. 1 BLAST FURNACE CAST HOUSE FUME COLLECTION SYSTEM

Figure 12



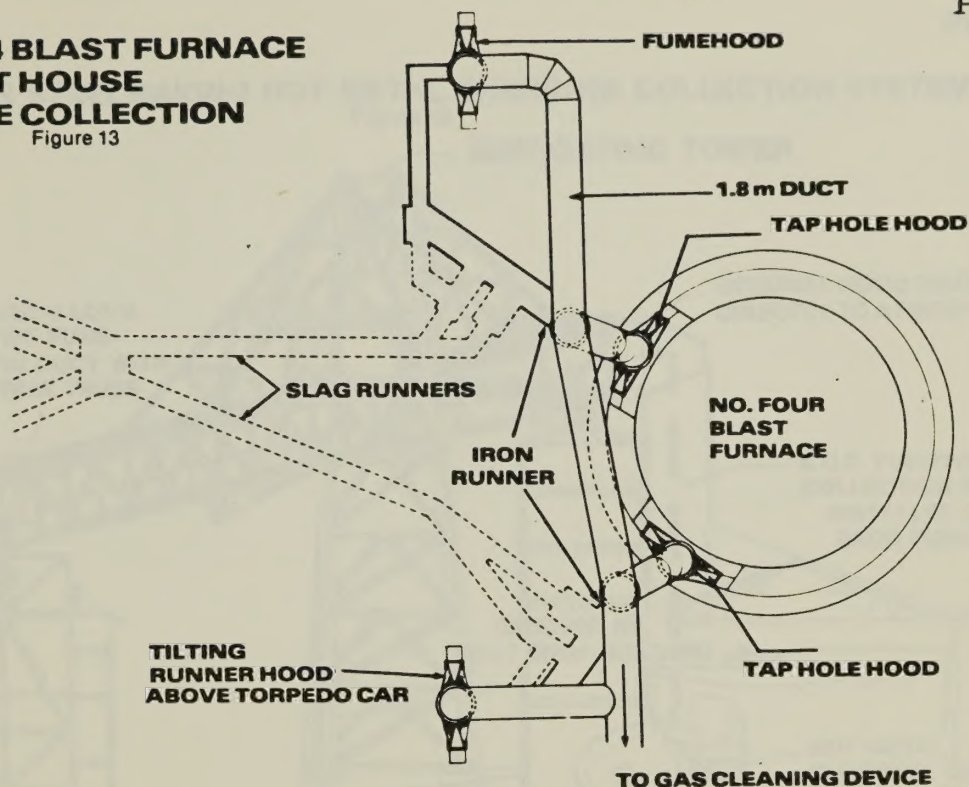


CAST IRON FURNACE COLLECTION SYSTEM



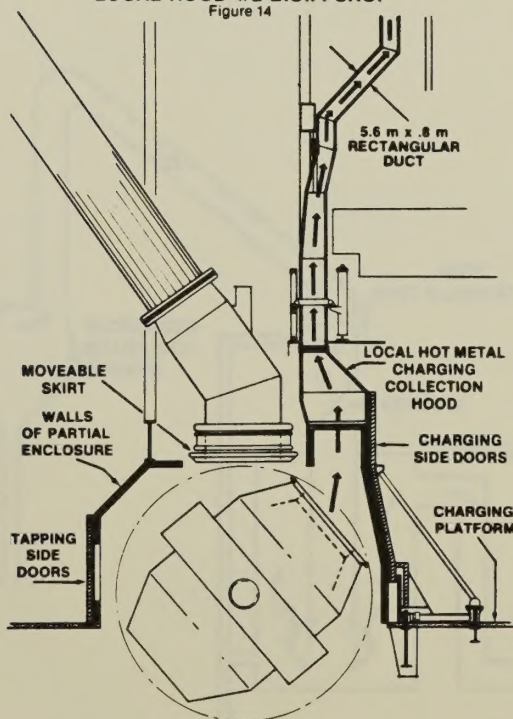
NO. 4 BLAST FURNACE CAST HOUSE FUME COLLECTION

Figure 13



PARTIAL ENCLOSURE AND LOCAL HOOD #2 B.O.F. SHOP

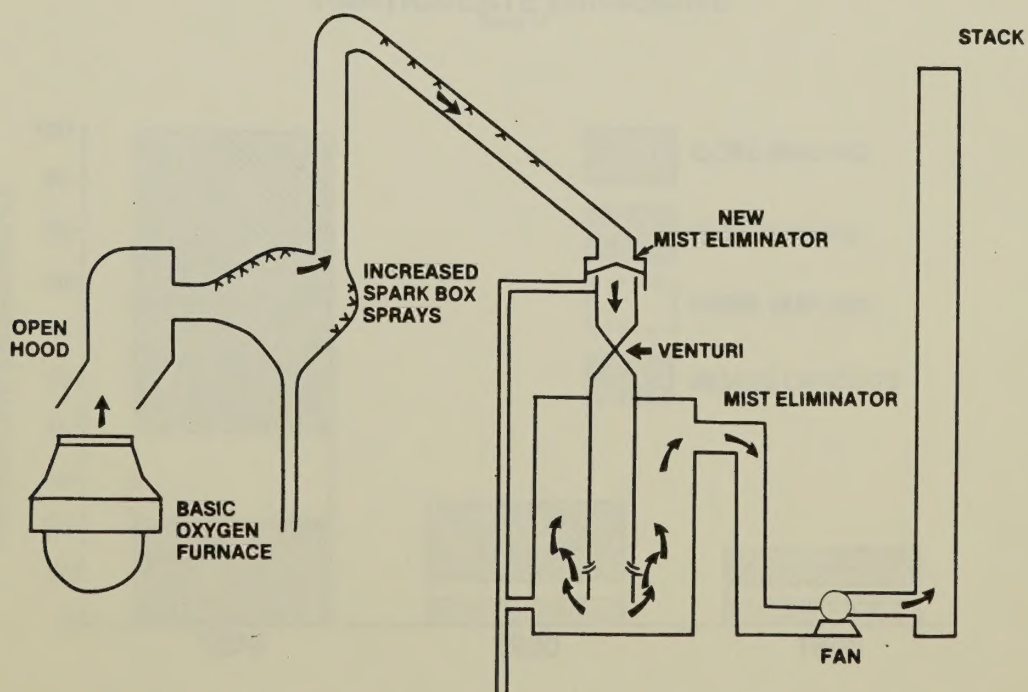
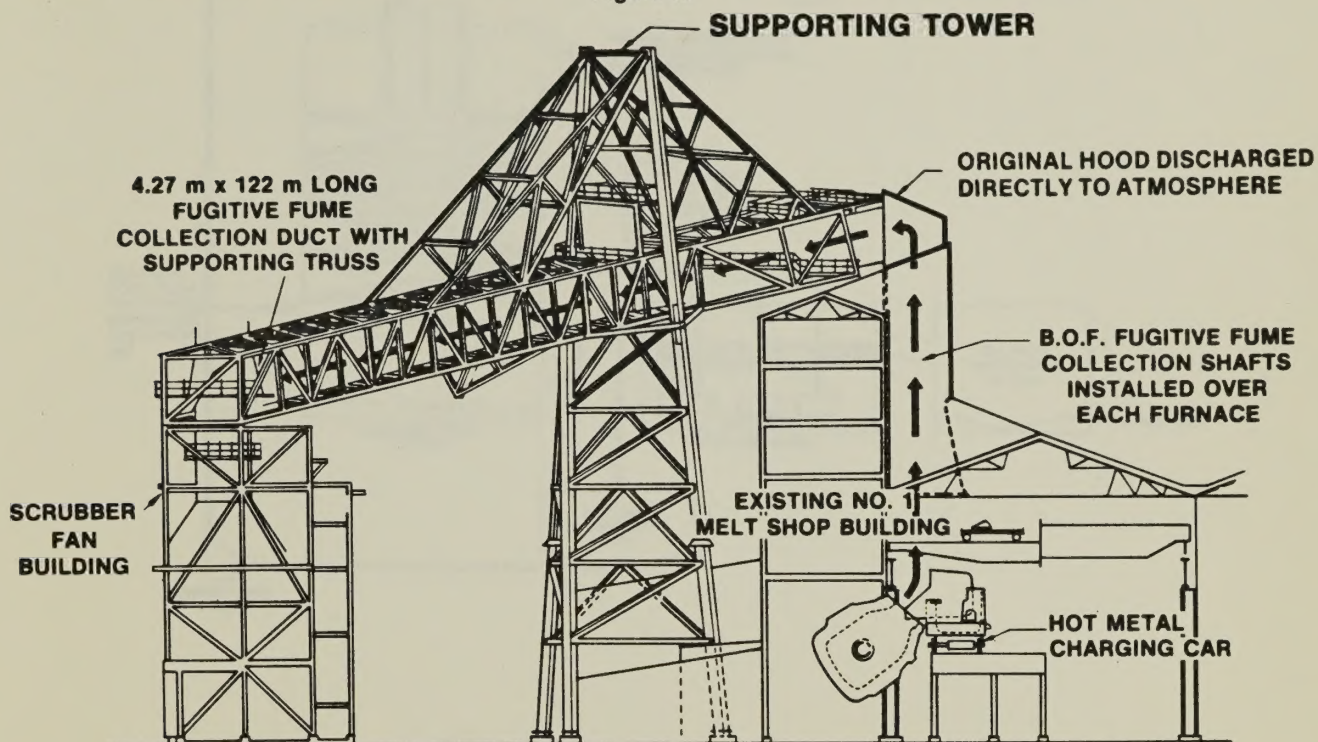
Figure 14





#1 OXYGEN STEELMAKING HOT METAL CHARGING COLLECTION SYSTEM

Figure 15



No. 1 BOF SHOP GAS CLEANING SYSTEM

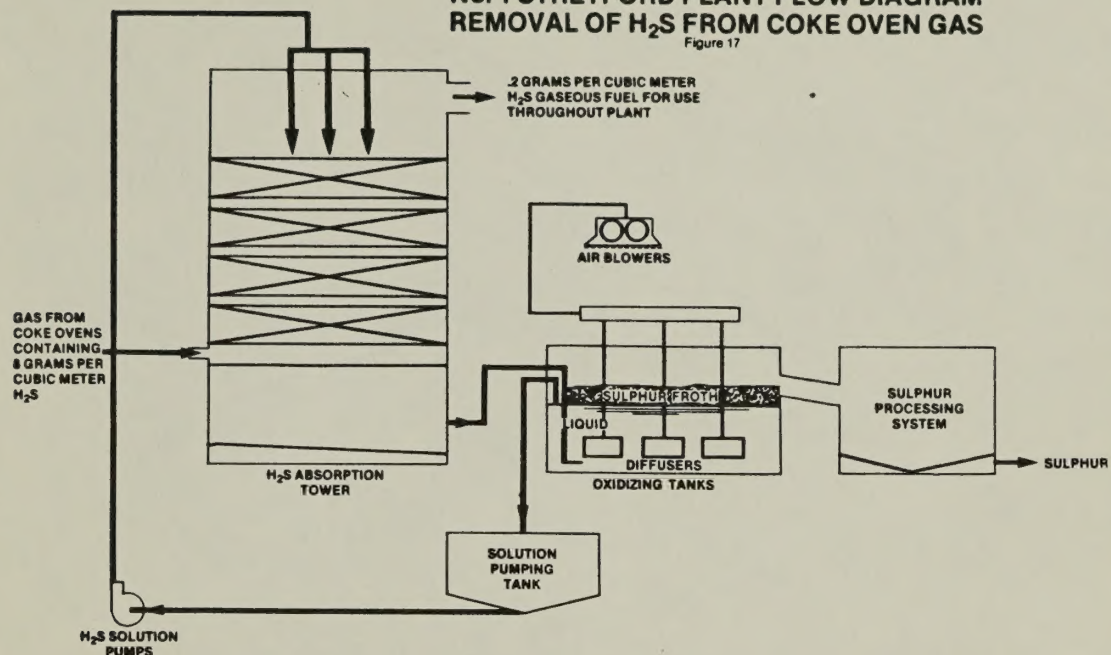
Figure 16

FIGURE 1: DESIGN OF THE NEWLY DESIGNED CLEANING SYSTEM



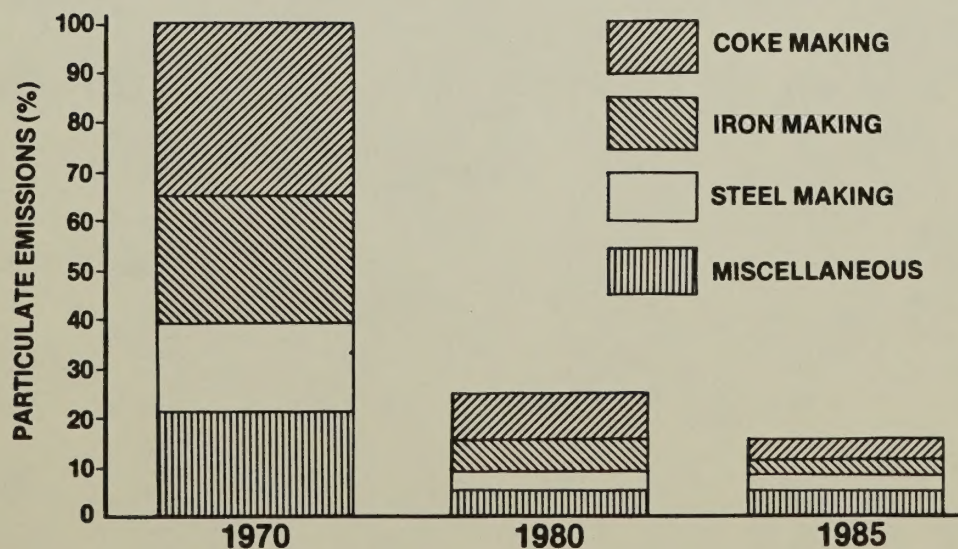
No. 1 STRETFORD PLANT FLOW DIAGRAM REMOVAL OF H_2S FROM COKE OVEN GAS

Figure 17



REDUCTION OF DOFASCO PROCESS PARTICULATE EMISSIONS

Figure 18





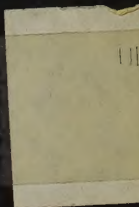
REDUCTION OF
DUSTS AND
PARTICULATE EMISSIONS



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MADE IN CANADA